THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 16 JANUARY, 1920 No. 1

THE INTESTINAL ANIMAL PARASITES FOUND IN ONE HUNDRED SICK FILIPINO CHILDREN [1]

By FRANK G. HAUGHWOUT

Protozoölogist, Bureau of Science, and Professor of Protozoölogy, University of the Philippines

and

FÉ S. HORRILLENO

Assistant in Pediatrics, Philippine General Hospital

ONE TEXT FIGURE

Surveys to determine the incidence of intestinal parasites are not a novelty in the Philippine Islands. Several excellent surveys have been made, the results of which are familiar to workers in tropical medicine. So far as we have knowledge, however, nothing approaching a survey by recent methods has been made among young Filipino children. This study can hardly be said to rank as a survey, for the number of cases considered is too small, but they have been studied with such care and thoroughness as to warrant us in the belief that we have missed few if any of the latent positives. One hundred twelve cases were studied, but twelve of these were dropped because of the death or discharge of the patient before investigation of the case was complete. The study of these cases has involved the examination of more than four thousand five hundred microscopic preparations and more than five hundred stool concentrations.

In undertaking this study we believed it possible that we might secure some suggestive data that might lead to an investigation, on a more extensive scale, into the possible influence on infant mortality in the Philippine Islands of infestation by

[1] Contribution from the Bureau of Science and the department of pediatrics, College of Medicine and Surgery, University of the Philippines.

169496

intestinal animal parasites. On reviewing our results and conclusions, we believe that we have at least been partly successful and that we have developed some suggestive matter.

At this time we desire to express our gratitude to Prof. José Albert, chief of the department of pediatrics of the Philippine General Hospital, and a leader in the movement to reduce infant mortality among the Filipinos, who has freely placed the patients on his service at our disposal, and who has in other ways aided and encouraged the work.

Of the one hundred children who remained under our control sufficiently long to admit of a thorough examination of their fæces, 92 per cent were found to be parasitized. This is 3 per cent under the number reported in 1909 by Garrison and Llamas(23) in their examination of the stools of one hundred fifty-eight Manila children, but sufficiently high to warrant endorsement of the statement by Garrison in 1908 [2] that—

> The population of the Philippines presents a higher percentage of infection with intestinal worms than has ever been definitely reported from any other people and the condition is essentially a chronic one, the results of which manifest themselves indirectly in the general physical impoverishment of the people and the high rate of morbidity and mortality accredited to other diseases.

If there is any one point that has been made clear by this brief study, it is the need for careful investigation of the effects produced by each parasite we have found. We have studied cases in which we have found as many as six species of parasites—multiple parasitism has been exceedingly frequent. In the presence of such an array of infesting organisms, showing such a variety of conduct as to mode of life and nutrition, it is exceedingly difficult to analyze cases with respect to the effects produced by the individual parasites.

Another striking point is the absence of infections with obligatory tissue parasites, such as *Entamœba histolytica* and *Balantidium coli*,[3] no case of infection with either having been encountered in our series. Furthermore, Professor Albert informs us that in his practice he has rarely encountered entamœbiasis

[2] Philip. Journ. Sci. § B 3 (1908) 73.

[3] We apply the term "obligatory tissue parasite" to *Balantidium coli* with a mental reservation. We are of the opinion that *Balantidium* is rather closely adapted to tissue parasitism, but the fact that the *motile forms* are frequently found in cases exhibiting no symptoms of colitis implies that it may be capable of living in the lumen of the intestine and deriving its nourishment from the contents thereof over comparatively long periods of time.

among children under 15 years of age. He has been able to recall only a very few cases in an experience extending over nearly thirty years. The senior author, in several years' observation, has seen only one case of infection with *Balantidium* in a young child. The child was under treatment for bacillary dysentery at the time the ciliates were discovered in its fæces; and, although the case has since been observed from time to time, no further dysenteric symptoms have been noted.

Obligatory tissue parasites, such as *Entamœba histolytica* and *Balantidium*, when they give rise to trouble, usually produce symptoms of a fairly positive character; not so with the parasites we have found in this series. We feel we cannot go beyond the statement that the association of *Ascaris* and *Trichuris* seems to evoke a more or less constant symptom-complex which, however, is subject to confirmation by the microscopist. The physician is forced to lean heavily on the microscopist for diagnosis of these cases, simple as they seem, for we have a record of more than one patient in this series to whom santonin had been given for ascarids that were not present in the intestinal tract. In only two instances have we failed to detect the ova of *Ascaris* in the fæces of cases that later were shown to be infected through vomiting or defecation of worms. The possible reasons for our failure to detect these infections will be discussed later.

Leaving aside, for the time being, a discussion as to the pathogenicity of the parasites we have encountered, it is perfectly clear that they are, to say the least, undesirable guests. The utter misery and wretchedness, if not actual suffering, they produce, apart from any other harm they may inflict upon their unhappy little hosts, are sufficient in themselves to bring about a vigorous repudiation and condemnation of the statements made in so many textbooks of medicine that these parasites are, for the most part, neither important nor particularly dangerous.

In dealing with the general problem of intestinal parasitism, we believe that the parasites may injure their hosts in many ways. Among the possible effects that may be produced by them are:

1. The production of antigrowth vitamines or growth-inhibiting substances.
2. The production of substances directly toxic, cytolytic, or hæmolytic.
3. Unfavorable effects upon the host through the liberation of the products of metabolism of the parasite.
4. Mechanical irritation of the mucous surfaces by the parasites when present in large numbers.

5. The conveyance of pathogenic organisms from one part of the body to another.
6. Interference with absorption in the intestine through the adherence of large numbers of parasites to the surface of the epithelium, as in the case of *Giardia*.
7. Actual invasion and destruction of the tissues with all its concomitants and sequelæ.

The children included in this series ranged in age from 7 months to 13 years. The girls numbered fifty-three, and 86.6 per cent of these were parasitized. There were forty-seven boys, 97.8 per cent of whom were parasitized, the incidence of infection in the boys being higher by 11.2 per cent than in the girls.

Considered in groups, 66.6 per cent of the children under 1 year of age were found to be infested. This was a very small group, consisting of only nine cases, and we are not inclined to generalize on that incidence. It does show, however, that even breast-fed children are not free from parasitism under the conditions obtaining here. The second group, formed of children between the ages of 1 and 2 years, was shown to be infected to the extent of 73.6 per cent. This gives the total incidence of infection in our series of children between the ages of 7 months and 2 years as 71.4 per cent. We may add that we had no opportunity to examine any child under the age of 7 months.

The third group, comprising children more than 2 years and not more than 13 years of age, showed 100 per cent infection. This group was formed of seventy-two children, all of whom, without exception, were infested with one or more parasites. Notwithstanding the group was small, the results are rather startling. We can only say that there was absolutely no selection of cases, and this fact was discovered only when we began to tabulate and study our results at the conclusion of the examinations.

The earliest infection was found in a child 7 months old, which was found to harbor *Spirochæta eurygyrata* and *Ascaris lumbricoides*. Allowing for the period of development of the worm before ovulation, this infection took place certainly not later than between the fifth and sixth months following birth. Unfortunately we were unable to secure data as to the feeding and other habits of the child. The infection apparently was light, for it was detected only on the second concentration of the stool, and the ova were few and far between.

Another child showed an infection with *Trichuris trichiura* at the tenth month which, allowing for the development of the

worm, must have been contracted not later than the ninth month. This, also, was a light infection, although it was detected on the first concentration of the stool. Further reference will be made to this case later on.

The protozoal and helminthal findings are recorded in Table 1. In this table are considered only protozoa in the strict sense. "Blastocystis" and *Spirochæta eurygyrata* are excluded; but, in view of the recent work of Kofoid, Kornhauser, and Swezy(35) and of Brug(5) we include Wenyon's "I Cysts" under the protozoa without at this time expressing an opinion as to whether they are the cysts of *Entamœba nana* (*Endolimax nana*) or "Entamœba williamsi."

So far as "Blastocystis" is concerned, we record it as a parasite without regard to its pathogenic or nonpathogenic possibilities. It was found alone, to the exclusion of all other parasites, in only one of our cases. In each case where we have recorded "Blastocystis," we have done so only after satisfying ourselves, beyond a reasonable doubt, that we were not dealing with aberrant cysts of some definitely known protozoön. We have classified all intestinal spirochætes as *Spirochæta eurygyrata* for we were unable to determine, without a tedious and time-consuming series of measurements, whether or not we were encountering any of the other spirochætes that have been reported from the human intestine.

TABLE 1.—*Protozoal and helminthal findings.*

	Cases.	Total infections.
With protozoa	33	41
With protozoa alone	2	
With helminths	80	138
With helminths alone	49	
Mixed protozoal and helminthal infections	31	
Spirochæta eurygyrata alone	8	
"Blastocystis" alone	1	

The parasites recorded by us in this study lie in thirteen genera and as many species. We have adopted Brug's designation(5) of *Entamœba nana* as *Endolimax nana,* and in the case of hookworm infections we have made no attempt to distribute them between the genera *Ancylostoma* and *Necator,* but have simply recorded them as "hookworm."

The incidence of the various parasites is set forth in Table 2.

Table 2 shows *Trichuris trichiura* to be the most prevalent

TABLE 2.—*Incidence of protozoa and helminths.*

Parasite.	Males.	Females.	Cases.
Spirochæta eurygyrata	33	28	61
"Blastocystis"	14	20	34
Entamœba coli	2	5	7
Endolimax nana	3	4	7
Dientamœba fragilis	3	0	3
Trichomonas intestinalis	6	4	10
Giardia intestinalis	7	1	8
Eutrichomastix sp. (?)	0	1	1
Chilomastix mesnili	0	3	3
"I Cysts"	1	1	2
Trichuris trichiura	33	36	69
Ascaris lumbricoides	24	32	56
Hookworm	4	8	12
Oxyuris vermicularis	1	0	1

parasite in the series. *Spirochæta eurygyrata* comes next, and *Ascaris lumbricoides*, third. Table 1 has shown the comparatively low incidence of protozoal as compared with helminthal infections, a condition we shall discuss farther on. It is to be noted that no evidence of either cestode or trematode infection was discovered in any case.

By far the greater number of patients studied resided in Manila, only twenty-three having come from the provinces. Obviously we have dealt with too few cases to enable us to draw any conclusion regarding either geographical distribution or the incidence of any particular parasite in the several localities. Incidentally, we might remark, however, that previous work has shown that the geographical distribution of animal parasites in the Philippine Islands is somewhat irregular, the trematodes, with the exception of *Echinostoma ilocanum*, for instance, being found in the southernmost provinces only. A thorough bionomic study would undoubtedly reveal the reason for this seemingly anomalous condition.

Be that as it may, however, 92.2 per cent of the children residing in Manila were found to be infested with parasites. Only one child in the provinces was uninfested, thus giving us a provincial incidence of 95.2 per cent. This child was 1 year old and had always been breast-fed. The locality from which it came is not renowned for its sanitation, but the immediate surroundings of the child were, nevertheless, "clean."

We have made careful inquiry into the immediate home surroundings and habits of these patients and the water drunk by them—as to whether it came from wells, the city water supply, or some other source. We are led to the conclusion that the

immediate surroundings and the water drunk have less bearing on the incidence of parasitism than is generally believed. We have recorded children living under the best hygienic conditions as regards cleanliness of surroundings but who, notwithstanding, were more or less heavily parasitized; and, in contrast, we have found instances where the children lived in surroundings that were filthy and overcrowded, but who survived the ordeal and failed to exhibit the slightest evidence that they were parasitized with either helminths or protozoa. It is perhaps easier to explain the first than the second condition.

The geographical distribution of our cases is set forth in Tables 3 and 4.

TABLE 3.—*Incidence of parasitism in Manila.*

District.	Cases.	Parasitized.	Not parasitized.
Binondo	2	1	1
Ermita	5	5	
Intramuros	1	1	
Malate	7	7	
Paco	10	10	
Pandacan	1	1	
Quiapo	1	1	
Sampaloc	9	8	1
San Lazaro	2	1	1
San Miguel	1	1	
Santa Ana	4	4	
Santa Clara	1	1	
Santa Cruz	12	9	3
Santa Mesa	3	3	
Singalong	6	6	
Tondo	5	5	
Trozo	2	2	
Undetermined	5	5	
Total	77	71	6

TABLE 4.—*Incidence of parasitism in the provinces.*

Province.	Cases.	Parasitized.	Not parasitized.
Bataan	1		1
Batangas	1	1	
Bulacan	1	1	
Cavite	5	5	
Mindoro	1	1	
Nueva Ecija	1	1	
Pampanga	2	2	
Pangasinan	2	2	
Rizal	9	9	
Total	23	22	1

MATERIAL AND METHODS

The cases were all drawn from the pediatrics ward in the Philippine General Hospital. There was no selection, the patients simply being taken as they were admitted. The larger proportion included children admitted for the treatment of disorders of the digestive and respiratory tracts, which preponderate over other diseases treated in the children's wards; but there were cases of malaria, beriberi, chorea, and other maladies. One or two developed cholera (a disease notoriously difficult to diagnose in children) during their stay in the hospital. Relatively few came in for treatment directed specifically against parasites.

The general plan comprehended at least five separate stool examinations, extending over seven to ten days, as circumstances permitted. At each examination three cover-glass preparations of the fresh material were carefully studied, five slides were fixed and stained for subsequent study, and at least 1 gram of the stool (samples being taken from different parts of the stool) was concentrated by the method of Cropper and Row.(10)

In the examination of the fresh specimen the fæces were diluted, when necessary, with physiological salt solution faintly tinted with neutral red. Cysts were studied with double strength Gram's iodine solution containing a small amount of glycerin, and with Aragao's modification of Hayem's solution. The former was found to give the best results. A careful study in each case was made of the cellular exudate, and in nearly every case the microscopic diagnosis of bacillary dysentery was confirmed by the clinical course of the disease. The fæces were not examined bacteriologically.

The stained preparations were all fixed in Bouin's picro-aceto-formol solution. Two of the five were stained in Mayer's hæmalum, which is admirable for cysts, and the other three by Dobell's iron-hæmatein, which gives beautiful results with trophozoites. Occasionally smears were treated by the Benians Congo-red method for the demonstration of spirochætes. The latter were very frequently detected in the fresh material and always appeared in the stained preparations. Smears from cases infected with flagellates were occasionally stained by Giemsa's method after methyl-alcohol fixation (following brief exposure to the vapor of osmic acid), because this gives an excellent demonstration of the flagella which can then be readily counted.

We used the ether-concentration method of Cropper and Row in preference to any of the excellent flotation methods, because our experience bears out that of Cropper and Row that solutions of high concentration have a tendency to distort protozoan cysts, thereby rendering their identification more difficult. The flotation method is unquestionably an excellent and convenient one when the search is restricted to ova of helminths.

In no case did we detect cysts of protozoa on concentration that we failed to find in the course of examining the slides of fresh or stained material.

Our method did not differ essentially from that of Cropper and Row, except that we emulsified the fæces in a test tube. The lumps of fæces were transferred to the tube with a small amount of saline solution and then thoroughly broken down and emulsified by stirring with a glass rod. Saline solution was gradually added and the stirring continued until there was complete emulsification of the mass. The maximum amount of solution was then added and the tube thoroughly shaken for several minutes. The entire sediment left in the centrifuge tube was examined microscopically.

This method, of course, necessitated careful attention to the cleansing of all utensils. This was not entrusted to the laboratory attendant, but was performed by one of us. All the apparatus was thoroughly washed off in a strong stream of running water, carried into a jar of strong lysol solution, and repeatedly scrubbed out with a stiff test-tube brush, the lysol being changed several times, after which the apparatus was again subjected to running water and carefully dried with absorbent cotton rolled around a small stick of wood.

Notwithstanding our figures are not widely different from those recorded by careful workers in the Philippines in the past, we would, had we not employed concentration methods, have missed 32.6 per cent of the helminthal infections. Table 5 shows the infections picked up on concentration that were missed on direct examination.

TABLE 5.—*Infections detected only on concentration.*

Trichuris	31
Hookworm	8
Ascaris	5
Oxyuris	1
Total	45

Furthermore, two cases (Nos. 20 and 34) were missed in the laboratory, but later proved to be infested with *Ascaris* through

the vomiting or passage of worms by the patients during their stay in the ward.

Several factors, some of them rather remote to be sure, may intervene to defeat a laboratory diagnosis in certain cases of nematode infection. The parasites may be present in exceedingly small numbers; but in such cases, unless one or more of the other conditions to be mentioned is present, the infection is almost certain to be detected sooner or later, especially if concentration methods are employed. The worms may be too immature to produce eggs. In such an event a wait of three or four weeks at the most, in a suspicious case, will probably settle the matter. Such cases would hardly be likely to develop symptoms, however. All the worms present may be males—a remote possibility, but one that has been shown by Hall(25) to exist in lower animals. Added to these is the difficulty experienced in handling dysenteric stools, especially those containing considerable mucus; but we believe it is possible, in the greater number of such instances, to pick up helminthal infections during the course of a series of examinations such as we have conducted. We failed to detect the ova of helminths in six individuals among the twenty-two cases of ileocolitis that occurred in our series. Of these six negative cases, four were found in the group of children between the ages of 1 and 2 years, eight cases of ileocolitis having occurred in that group. This group has been shown to have yielded 26 per cent less infections than the other higher groups and about 7 per cent more than the 7 to 12 months group. However, it must be admitted that stools of that character are troublesome and uncertain to deal with, but as we were taking the general run of cases, we had to deal with conditions as we found them. Incidentally, we might remark that we were unable to determine any marked tendency to expel worms during the course of a febrile disorder. It did occur in some instances, but it was not an invariable event.

For some reason or other the ova of *Ascaris* and *Trichuris* occasionally failed to come down on centrifugation. This occurred ten times in the case of *Ascaris* and five times in the case of *Trichuris*. The infections, however, were either detected on the slides or were thrown down in subsequent—or, in some cases, earlier—concentrations. One very odd situation was afforded by a case that was persistently negative for *Trichuris* on concentration and on examination of fresh cover-glass

preparations. It was marked negative until a solitary egg of *Trichuris* was found on one of the stained preparations.

It would probably take careful study to determine the exact reasons for these occurrences. It seems likely that they were due to some error in technic such as insufficient dilution on shaking of the emulsion, or slowing down or speeding up of the centrifuge, which at times ran irregularly. In the case of *Ascaris* it has occurred to us that possibly the gelatinous coat of the egg may at times absorb ether and prevent the ova from settling in the separatory funnel.

Out of the twelve hookworm infections found, four were diagnosed on direct microscopical examination of the fresh fæces, the remaining eight being found only on concentration.

Many of the protozoal findings were not made until the stained preparations were studied; because, for the most part, they were light infections with the exception of those with *Trichomonas intestinalis,* which usually were fairly heavy. It was necessary, however, to study the stained preparations for the identification of *Endolimax nana* and *Dientamœba fragilis,* and to count the flagella of the trichomonads. The hæmalum preparations served as a check on encysted forms of the amœboid group, but Dobell's method gave the best pictures of the cysts of *Giardia* and *Chilomastix.*

Before passing on to a detailed consideration of the various groups of children, it seems worth while briefly to mention those cases that were not parasitized. As has been said, all of these occurred in children under the age of 2 years. Of these (eight) cases, one (case 32) is known to have been parasitized in the past, for it gave a history of having vomited an ascarid before admission. Like the others, this case was persistently negative on repeated examination, so there exists the possibility that the worm vomited was the only one with which the child was infested. The data on these cases are presented in Table 6.

It is interesting to note that, notwithstanding five of these children were seriously ill, there was only one death in the nonparasitized group. This was the case of a girl (No. 52) with a severe ileocolitis that ran a protracted course of more than a month. The child developed a secondary stomatitis and finally died of exhaustion. She had been ill for three weeks before coming to the hospital.

There were nine deaths in the series, only one of which occurred in a nonparasitized child. This was the case (No. 52)

TABLE 6.—*Cases not parasitized.*

[R, recovered; I, improved; D, died.]

Case.	Age.	Sex.	Diagnosis.	Termination.
	Mos.			
3	24	♀	Ileocolitis with secondary bronchitis; severe	R
5	14	♀	Ileocolitis; moderately severe	I
32	22	♀	Bronchial asthma; rachitis; indigestion. (Vomited an ascarid before admission.)	I
52	14	♀	Ileocolitis; secondary stomatitis	D
57	10	♀	Indigestion	R
64	12	♀	——do	R
88	18	♂	Bronchopneumonia; moderately severe	I
100	12	♀	Malaria with secondary splenomegaly	I

that has just been mentioned. Strangely enough, not one of these was infected with protozoa sensu stricto. The data on these cases are presented in Table 7.

The age distribution and incidence of the several parasites together with the number of cases in each group are presented in Table 8.

Inspection of Table 8 will show that infection with *Spirochæta eurygyrata*, "Blastocystis," *Trichuris*, and *Ascaris* takes place exceedingly early in the life of the child, and these parasites are found in children of every age up to our limit of 13 years. Hookworm infections in Manila and the vicinity apparently do not get a fair start much before the sixth year, only an isolated case having been picked up between the third and fourth years. Protozoal infections begin to take place after the first year and are more or less uniformly distributed through the series thereafter.

Tables 9 to 21 summarize the laboratory and clinical data throughout the entire series. It has been found interesting to break the series up into thirteen groups representing each year of the child's life, for it was felt that such an arrangement might form a useful basis for comparison in later work. The parasites recorded represent only those found in our laboratory examinations, without reference to the passage or vomiting of worms before the child entered the hospital, or to the cases where children vomited or passed ascarids in the ward when laboratory examination had failed to discover the ova. There were only two such instances.

The clinical diagnosis is that made in the ward and does not necessarily include the laboratory diagnosis. It is mainly a record of the salient features of the diagnosis as made when

TABLE 7.—*Deaths from all causes.*

Case.	Age.		Sex.	Cause.	Parasites found.		
					Miscellaneous.	Protozoa.	Helminths.
	Yrs.	*mos.*					
11	3	0	♀	Ileocolitis; gingivitis	"Blastocystis"		*Trichuris; Ascaris.*
13	3	0	♀	Ileocolitis; stomatitis; septicæmia	do		*Trichuris.*
22	7	0	♀	Tuberculosis; pleurisy and effusion			*Trichuris; Ascaris;* hookworm.
38	3	0	♂	Tuberculous peritonitis	*Spirochæta*		*Trichuris.*
46	1	0	♂	Bronchopneumonia	"Blastocystis;" *Spirochæta*		*Trichuris; Ascaris.*
52	1	2	♀	Ileocolitis; exhaustion			
54	10	0	♂	Typhoid; intestinal hæmorrhage			*Trichuris; Ascaris.*
91	1	8	♂	Ileocolitis; gangrenous gingivitis	*Spirochæta*		*Ascaris.*
98	8	0	♀	Ileocolitis; bronchopneumonia	do		*Trichuris; Ascaris.*

TABLE 8.—*Age distribution and incidence of parasites.*

Age.	Cases in group.	*Spirochæta eurygyrata.*	"Blastocystis."	*Entamœba coli.*	*Endolimax nana.*	*Dientamœba fragilis.*	*Trichomonas intestinalis.*	*Giardia intestinalis.*	*Eutrichomastix* sp. (?)	*Chilomastix mesnili.*	"I Cysts."	*Trichuris trichiura.*	*Ascaris lumbricoides.*	Hookworm.	*Oxyuris vermicularis.*
7 months to 1 year	9	5	1	----	----	----	----	----	----	----	----	2	2	----	----
1 to 2 years	19	10	1	----	1	----	1	----	----	----	----	5	7	----	----
2 to 3 years	11	3	4	1	----	----	1	----	----	1	----	9	9	----	----
3 to 4 years	11	9	3	----	----	----	1	2	----	----	----	9	6	1	----
4 to 5 years	11	7	3	3	----	----	----	----	----	1	----	10	5	----	----
5 to 6 years	6	6	3	----	3	----	----	1	----	1	----	5	5	----	----
6 to 7 years	8	5	4	1	----	----	2	1	----	----	----	6	6	3	----
7 to 8 years	7	3	5	----	1	2	2	3	----	----	1	7	4	1	----
8 to 9 years	3	3	1	1	----	----	1	----	----	----	1	3	1	3	----
9 to 10 years	5	3	2	----	----	----	1	1	1	----	----	4	4	2	----
10 to 11 years	3	2	2	1	1	1	----	----	----	----	----	3	2	----	1
11 to 12 years	4	3	4	----	1	----	----	----	----	----	----	4	4	1	----
12 to 13 years	3	2	1	----	----	----	1	----	----	----	----	2	1	1	----
Total	100	61	34	7	7	3	10	8	1	3	2	69	56	12	1

the patient was received in the hospital. The termination records the status of the patient at the time the entire series of observations was concluded. It was necessary to record them thus, because several patients remained in the hospital after the work was completed and others were transferred to other institutions and thus passed out of our control.

By physical development should be understood the condition presented to the physician on admission—that is to say, the general physique and nutrition of the patient as brought out in the usual physical examination.

Circumstances made it impossible for us to make an exact determination of the mental development of these children, such as the application of the Binet-Simon test. The mental fitness of each child was simply appraised after watching its conduct with its toys and with the other children in the ward, the readiness with which it answered questions, and its general ability to talk, walk, and otherwise behave in harmony with its age. In later work it would probably be found desirable to enlist the coöperation of a specialist in child psychology, or, failing that, it might be found convenient to use the Standard Score Card for Babies as outlined by the American Medical Association. This has already been employed in an interesting series of observations on Filipino children by Albert and Arvisu.(2)

Unless otherwise noted, the column devoted to abdominal symptoms records the symptoms observed by the patient or those with whom he lived prior to the onset of the disease that led to his being brought to the hospital. So many of the children included in this series were suffering from diseases of the alimentary tract, that in themselves give rise to more or less positive abdominal symptoms, that it was realized that this distinction must be drawn.

Symptoms referred to the nervous system presented some difficulty; but we followed the same general rule, eliminating, so far as we could, all phenomena clearly referable to some condition other than parasitism. We realize that we may not have been entirely successful in our treatment of this factor, but we have done the best we could under the circumstances.

When it came to collecting information as to the vomiting or passage of worms before the patient was admitted to the hospital, we had to rely largely on the statements of parents or others with whom the child lived; but we have felt perfect security in so doing, for it would probably not be easy to find a Filipino mother who did not know a round worm when she saw it. In all cases where reference is made in the table to the passage or vomiting of worms, it should be understood that the worm to which reference is made is *Ascaris lumbricoides*.

The youngest group of children is recorded in Table 9. With the exception of cases 46 and 56 none showed abdominal symptoms of any importance. Case 46 was infested with four parasites; while case 56, which showed the most marked symptoms, was rather lightly infected with *Trichuris*. Case 87, which was infected with *Ascaris*, had never, so far as we could ascertain, shown symptoms referable to the abdomen or the nervous system. The infection was light and, as has been said, was detected on the second concentration of the stool.

Case 46 had been breast-fed from birth to the time of admission, but after the eighth month the mother reënforced its diet with bread and rice. Case 56 had been bottled-fed since birth. We were unable to obtain reliable data on case 87. With the exception of case 63, which had been given other food from time to time, all the children had been breast-fed from birth to date of admission.

One of the most interesting cases in Table 10 is No. 83, a 2 year old girl who was admitted for treatment of an acute bronchitis. This child was infected with "Blastocystis," *Endolimax nana*, *Trichuris*, and *Ascaris*. The physical development of the child was only fair. She was abnormally quiet and, not-

TABLE 9.—*Findings in children between 7 months and 1 year.*

[R, recovered; I, improved; D, died.]

Case.	Age.	Sex.	*Spirochæta.*	"Blastocystis."	*Trichuris.*	*Ascaris.*	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
	Mos.													
46	12	♂	+	+	+	+	Tuberculosis; ileocolitis	D	Bad	Backward	Tympanitis and distention	None	—	—
51	12	♂	+				Acute bronchitis; pneumonia.	I	Fairly good	Normal	None	do	—	—
56	11	♀			+		Acute bronchitis	I	Emaciated	do	Distention, tympanism and vomiting.	Insomnia: irritability.	—	—
57	10	♀					Indigestion	R	Fair	do	Occasional flatulence	Irritable	—	—
63	11	♀	+				Malaria	I	Fairly well developed; poorly nourished.	do	Splenomegaly	None	—	—
64	12	♀					Indigestion	R	Fairly good	do	None	Occasional convulsive attacks.	—	—
71	8	♀	+				Bronchopneumonia	R	Good	do	Slight tympanism	None	—	—
87	7	♂	+			+	Acute bronchitis	R	do	do	None	do	—	—
100	12	♀					Malaria	I	Fairly good	do	Splenomegaly	do	—	—

withstanding her age, could not talk. There was a history of abdominal distention and occasional pain, but no symptoms referable directly to the nervous system. The infections were fairly heavy, but an inquiry into the gastronomic history of this patient robs this condition of some of its significance. We learned that the child had been breast-fed up to the age of 10 months; between that time and the age of 18 months she had subsisted on *linugao* (a native dish consisting of rice cooked to form a sort of porridge) and gruel, after which she had received the same rations as the adult members of the family. It is cases such as this that increase the difficulty of determining the symptoms referable directly to infestation with animal parasites. Case 99, infested with *Ascaris*, complained only of indigestion and slight distention. It had been breast-fed the first year and since then had received a variable diet including rice and bananas. Although it was 2 years old, the child was unable to talk.

The other cases in this group were fed as follows:

Case 2. Breast-fed for the first fourteen months; artificially fed thereafter.
Case 3. Breast-fed for the first five months; artificially fed thereafter.
Case 5. Breast-fed the first month; received pasteurized milk thereafter.

With the exception of case 2, which was infested with *Spirochæta eurygyrata*, these three children were free from parasites.

Case 16. Artificially fed "for a long time."
Case 32. Breast-fed for the first nineteen months; artificially fed thereafter.
Case 35. Breast-fed since birth.
Case 43. Breast-fed since birth, but lately it has been given an occasional artificial feeding.
Case 44. No data.
Case 52. Breast-fed the first ten months; artificially fed thereafter.
Case 59. Breast-fed the first thirteen months; artificially fed thereafter.
Case 62. Breast-fed until recently, when it was placed on artificial feeding.
Case 67. Breast-fed the first two months; since then the child has received condensed milk.
Case 72. From the viewpoint of the parasitologist this was one of the most interesting cases in the series, but unfortunately we could obtain no reliable data as to the child's diet.
Case 74. Breast-fed for the first year; artificially fed since then.
Case 76. Breast-fed since birth.
Case 88. No data.
Case 91. Breast-fed for the first eighteen months; artificially fed thereafter.

TABLE 10.—*Findings in children more than 1 and not over 2 years.*

[R, recovered; I, improved; U, unimproved; D, died; O, vomited; or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Age.	Sex.	*Spirochæta.*	"Blastocystis."	*Endolimax nana.*	*Trichomonas.*	*Trichuris.*	*Ascaris.*	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
	Mos.															
2	24	♂	+						Chronic indigestion	I	Emaciated but fairly developed.	Normal	Distention	Irritable	—	—
3	24	♀							Ileocolitis; bronchopneumonia.	R	Poor	do	None	do	—	—
5	14	♀							Ileocolitis	I	Good	do	do	do	—	—
16	24	♂					+	+	Tuberculosis; ileocolitis.	U	Poor	Backward; does not talk; fontanelle is still open.	Pain and distention	do	—	—
32	24	♀							Asthma; rachitis; indigestion.	I	do	Normal	Pain and distention relieved on vomiting worms.	Profuse sweating; irritability.	O	—
35	16	♀	+						Ileocolitis; stomatitis	R	Fair	do	Referable to present illness.	Occasionally irritable.	—	—
43	21	♂						+	Bronchopneumonia	R	Good	do	Occasional flatulence	None	—	—
44	24	♂	+						Intoxication secondary to constipation.	R	Fair	do	Slight distention	Convulsions	—	—
52	14	♀							Ileocolitis	D	do	do	Referable to present illness.	Irritable	—	—
59	15	♂	+				+		Bronchitis	R	do	do	None	None	—	—
62	18	♂	+						Bronchopneumonia	R	Good	do	Occasional diarrhœa, distention and tympanism.	do	—	—

| | | |

TABLE 11.—*Findings in children more than 2 and not over 3 years.*

[R, recovered; I, improved; U, unimproved; D, died; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Entameba coli.*	*Trichomonas.*	*Chilomastix.*	*Trichuris.*	*Ascaris.*	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
11	♀	----	+	----	----	----	+	+	Ileocolitis; gangrenous gingivitis.	D	Fair	Normal	Pain	None	O	—
13	♀	----	+	----	----	----	+	----	Ileocolitis; gangrenous stomatitis; septicæmia.	D	do	do	None	do	—	—
20	♀	----	+	----	----	+	+	----	Bronchitis; ascariasis	I	do	do	Frequent pain since the 18th month.	do	—	H
33	♂	+	----	----	----	----	----	+	Pulmonary tuberculosis; bronchopneumonia; pleurisy.	D	Poor	do	Pain, distention, and tympanism.	do	—	—
42	♀	----	----	----	----	----	+	+	Bronchopneumonia; alveolar abscess.	I	Fair	do	Occasional pain	Irritable	—	—
49	♀	----	+	+	----	----	+	+	Lobar pneumonia	I	Good	do	None	None	—	—
60	♀	----	----	----	----	----	+	+	Chorea; ascariasis	I	Fair; since 3d month, strabismus; falls in walking.	do	Frequent pain	Restless; cries without cause; sleepless at times.	—	O
75	♀	----	----	----	----	----	+	+	Bronchitis; chronic rhinitis.	R	Good	do	None	None	—	—
78	♂	+	----	----	----	----	+	+	Erysipelas; acute bronchitis.	U	do	do	do	Irritable	—	—
89	♀	----	----	----	+	----	----	+	Pulmonary tuberculosis; enteritis.	U	Poor	Does not talk.	Marked distention	None	—	—
96	♂	+	----	----	----	----	+	+	Phimosis; conjunctivitis catarrhalis.	R	Good	Normal	Slight distention	do	—	—

TABLE 12.—*Findings in children more than 3 and not over 4 years.*

[R, recovered; I, improved; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Cases.	Sex.	*Spirochæta.*	"Blastocystis."	*Trichomonas.*	*Giardia.*	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
23	♀	+				+		+	Lobar pneumonia	I	Fair	Normal	None	None	—	—
31	♀	+				+			Acute bronchitis	R	Good	do	Occasional pain and distention.	do	—	—
37	♀	+					+		Malaria	I	Fair	do	Occasional pain; splenomegaly.	do	—	—
39	♀					+	+		Bronchitis; ascariasis.	I	do	do	Pain and distention	Drowsy	—	O
41	♂	+				+			Tonsillitis	R	Good	do	Occasional pain	None	—	—
48	♂	+	+	+		+	+		Tuberculosis; bronchopneumonia; ascariasis.	I	Poor	Will not answer questions.	Frequent pain and twitching of body.	Dull to restless at times.	H	OH
61	♀		+						Paresis of upper and lower extremities.	I	Fair	Normal	Occasional pain	None	—	—
66	♂	+			+	+			Alveolar abscess	I	Good	do	Distention; occasional pain causing loss of sleep.	Wakes up and screams at night.	—	—
69	♀	+				+	+		Ascariasis	I	Fair	Normal, but does not play.	Distention and pain	Irritable. Trembles when frightened.	—	H
70	♂	+	+		+	+	+		Chorea	I	Fair development but nutrition poor.	Normal	Frequent pain and distention.	Fits of drowsiness; restless at times; insomia.	—	H
90	♂	+				+	+		Lobar pneumonia	R	Good	do	Frequent pain, relieved on passage of worms.	None	—	O

TABLE 13.—*Findings in children more than 4 and not over 5 years.*

[R, recovered; I, improved; U, unimproved; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Entamœba coli.*	*Chilomastix.*	*Trichuris.*	*Ascaris.*	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
1	♀	+	+	+	----	+	----	Ileocolitis; œdema.	I	Fair	Does not talk. Too quiet in bed. Will not answer questions.	Ascites	Dull	—	—
10	♂	----	----	----	----	+	----	Ileocolitis	I	do	Normal	Occasional pain	do	—	—
19	♂	+	+	----	----	+	----	do	R	Good	do	None	None	—	—
21	♀	+	+	----	----	----	----	do	R	do	do	do	do	—	O
27	♀	+	----	+	+	+	+	Ileocolitis / Mitral insufficiency	R / I	Fair	do	Pain and distention	do	—	—
30	♀	+	----	+	----	+	----	Ileocolitis; secondary nephritis; œdema.	U	do	Too quiet	Has twice passed *Ascaris* since 2 years old.	do	—	O
50	♀	----	----	----	----	+	+	Ileocolitis	R	Good	Normal	None	do	—	—
58	♀	+	----	----	----	+	+	Lobar pneumonia	R	Fair	do	Ocasional pain	do	—	—
73	♀	+	----	----	----	+	+	Bronchitis; ascariasis	I	Good	do	Frequent pain relieved by passage of worms.	do	O	OH
81	♂	----	----	----	----	+	+	Ascariasis	R	Good, but thin and pale.	do	Patient was writhing with pain on admission.	do	—	H
97	♂	----	----	----	----	+	----	Ileocolitis	I	Good	do	Occasional pain, relieved by passage of worms.	Once fainted 6 months ago; sweats; loss of activity and appetite.	—	O

TABLE 14.—*Findings in children more than 5 and not over 6 years.*

[R, recovered; I, improved; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Endolimax nana.*	*Giardia.*	*Chilomastix.*	*Trichuris.*	*Ascaris.*	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
8	♀	+	+	+	—	+	+	+	Malaria	I	Fair	Normal	Occasional pain relieved by vomiting worms.	Excitable	O	—
29	♂	+	—	—	—	—	+	—	Indigestion; ascariasis.	I	Rather poor	do	Distention and occasional pain with fever, relieved by passage of worms.	None	—	OH
33	♂	+	+	+		—	+	+	Malaria	I	Fair, but anæmic	do	Occasional pain	do	—	—
55	♂	+	—	—	+	—	—	+	Empyema	R	Fair	do	Occasional pain, relieved by passage of worms.	do	—	O
85	♀	+	+	+	—	—	+	+	Lobar pneumonia	R	Good	do	Distention and severe pain, relieved by passage of worms.	Very irritable	—	O
93	♂	+	—	—	—	—	+	+	do	R	do	do	Attacks of severe pain with vomiting and passage of worms.	None	O	O

TABLE 15.—*Findings in children more than 6 and not over 7 years.*

[R, recovered; I, improved; U, unimproved; D, died; O, vomited or passed *Ascaris* before admission.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Entamœba coli.*	*Trichomonas.*	*Giardia.*	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
12	♂	----	----	----	+	----	----	----	----	Tuberculosis Severe ileocolitis	U I	Poor	Answers questions slowly; dull and indifferent to surroundings.	Pain referable to ileocolitis.	None	—	—
14	♂	----	+	+	----	+	+	----	----	Ileocolitis	I	Well developed; poorly nourished.	Slow in answering questions; dull.	Occasional pain, distention, and tympanitis, with vomiting and passage of worms.	----do----	O	O
22	♀	----	----	----	----	----	+	+	+	Tuberculosis; pleurisy with effusion.	D	Poor; cannot stand	Normal, but dull at times.	Diarrhœal stools with passage of worms.	----do----	—	O
47	♀	+	----	----	----	----	+	+	----	Ileocolitis	R	Good	Normal	Occasional pain	----do----	—	—
79	♀	+	+	----	----	----	+	+	+	Influenza	R	----do----	----do----	Occasional pain relieved by passage of worms.	----do----	—	O
80	♀	+	----	----	----	----	+	+	----	Tuberculosis; bronchopneumonia.	U	Bad	----do----	Occasional pain	----do----	—	—
86	♂	+	+	----	+	----	----	+	----	Typhoid fever	I	Fair	----do----	Referable to the typhoid.	----do----	—	—
92	♂	+	+	----	----	----	+	+	+	Lobar pneumonia	R	Good	----do----	Frequent pain relieved by passage of worms.	----do----	—	O

TABLE 16.—*Findings in children more than 7 and not over 8 years.*

[R, recovered; I, improved; U, unimproved; D, died; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Endolimax nana.*	*Dientamœba.*	*Trichomonas.*	*Giardia.*	"I Cysts."	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
7	♀	—	+	+	—	—	+	—	+	+	—	Lobar pneumonia	U	Poor	Normal	None	None	—	—
18	♂	—	+	—	+	—	—	—	+	—	—	Post-infective psychosis; ascariasis.	R	Fair	Talks incoherently; shouts at times; does not recognize mother; formerly was normal.	Pain 4 days before admission, relieved by vomiting *Ascaris*.	See mental symptoms.	O	—
34	♂	—	—	—	—	+	—	—	+	—	+	Typhoid fever	R	do	Normal	Frequent pain with vomiting of *Ascaris*.	None	H	—
36	♂	+	+	—	—	+	+	—	+	—	—	Tuberculosis	I	do	do	Occasional pain with passage of *Ascaris*.	Very irritable	—	O
40	♀	+	+	—	—	—	—	+	+	+	—	Typhoid fever; parotitis.	R	do	Dull and indifferent.	Distention, tympanitis and occasional pain.	None	—	—
82	♂	—	+	—	+	—	+	—	+	+	—	Cerebral abscess; suppurative meningitis.	D	do	Normal	Occasional pain	do	—	—
98	♀	+	—	—	—	—	—	—	+	+	—	Ileocolitis	I	do	do	do	Irritable	H	—

TABLE 17.—*Findings in children more than 8 and not over 9 years.*

[R, recovered; I, improved.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Entamœba coli.*	*Trichomonas.*	"I Cysts."	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
25	♀	+	---	---	---	---	+	---	+	Malaria	I	Fair	Normal	Chronic constipation	None	---	---
53	♀	+	+	+	+	+	+	---	+	do	I	do	do	Constant feeling of heaviness; no actual pain.	do	---	---
77	♂	+	---	---	---	---	+	+	+	Lobar pneumonia	R	Good	do	Occasional pain	do	---	---

TABLE 18.—*Findings in children more than 9 and not over 10 years.*

[R, recovered; I, improved; U, unimproved; D, died; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Trichomonas.*	*Giardia.*	*Entrichomastix* (?)	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
9	♀	----	+	----	----	+	+	+	+	Ileocolitis; eczema; ascariasis.	R	Fair, but pale and anæmic.	Normal	Occasional pain with passage of worms.	None	—	O
15	♀	+	----	+	----	----	+	+	----	Ascariasis	I	Fairly developed, but emaciated and anæmic; has had fainting fits.	do	Severe pain accompanied by distention and vomiting of worms.	do	H	—
54	♂	----	----	----	----	----	+	+	----	Typhoid fever; parotitis; conjunctivitis.	D	Fair	do	None	do	—	—
65	♀	+	+	----	----	----	+	+	+	Epilepsy; occasional convulsions.	U	Good; teeth irregularly developed; posterior part of head flat.	Feeble-minded; melancholic; does not answer questions intelligently; grimaces.	do	do	—	—
84	♂	+	----	----	+	----	----	----	----	Infected wound of foot; tetanus.	R	Good	Good	Occasional pain and diarrhœa.	do	—	—

TABLE 19.—*Findings in children more than 10 and not over 11 years.*

[R, recovered; U, unimproved.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Entamœba coli.*	*Endolimax nana.*	*Dientamœba.*	*Trichuris.*	*Ascaris.*	*Oxyuris.*	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
28	♀		+				+			Pleurisy with effusion.	R	Fair	Normal	None	None		
										Mitral insufficiency.	U						
45	♀	+			+	+	+	+	+	Typhoid fever	R	Good	do	do	do		
68	♀	+	+	+			+	+		Influenza	R	do	do	Occasional pain and fullness in epigastrium.	do		

TABLE 20.—*Findings in children more than 11 and not over 12 years.*

[R, recovered; I, improved; O, vomited or passed *Ascaris* before admission; H, vomited or passed *Ascaris* in hospital.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Endolimax nana.*	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
6	♂	----	+	----	+	+	----	Ascariasis	I	Fair	Normal	Frequent, acute pain with vomiting and passage of worms; this occurs about twice a month, worms being vomited each time.	Easily excited; timid.	OH	OH
17	♀	+	+	----	+	+	----	Influenza	R	do	do	None	do	—	—
94	♂	+	+	+	+	+	----	Tuberculosis	I	Fair but anæmic	do	Occasional pain; severe at times	do	—	—
95	♀	+	+	----	+	+	+	Influenza	R	Good	do	None	do	—	—

TABLE 21.—*Findings in children more than 12 and not over 13 years.*

[R, recovered; I, improved; O, passed *Ascaris* before admission.]

Case.	Sex.	*Spirochæta.*	"Blastocystis."	*Trichomonas.*	*Trichuris.*	*Ascaris.*	Hookworm.	Clinical diagnosis.	Termination.	Physical development.	Mental development.	Abdominal symptoms.	Nervous symptoms.	Vomited worms.	Passed worms.
4	♂	+	----	----	+	----	----	Beriberi	R	Good	Normal	Occasional epigastric pain with no relation to meals.	Occasional dizziness.	—	—
24	♂	----	----	----	+	+	----	Tuberculosis	I	Poor	do	No pain, but patient occasionally passes worms.	None	—	O
26	♀	+	+	+	----	----	+	Hysteria; ancylostomiasis; ascariasis.	I	Small and undeveloped, no signs of puberty; pale and jaundiced.	do	Persistent pain in upper abdomen, of 5 years duration.	Sentimental to melancholic.	—	—

From the foregoing data it will be seen that breast and artificial feeding do not necessarily confer freedom from parasitism. It appears to us that they somewhat reduce the chances of infection. Two children (Nos. 35 and 76) aged 16 and 13 months, respectively, had been breast-fed since birth and, so far as the laboratory findings and history showed, had escaped infection with protozoa or helminths although both were infected with spirochætes. One gains the impression that trouble starts with the beginning of artificial or bottle feeding. We shall discuss the factors involved later on.

The group shown in Table 10 comprised nineteen cases, of which eleven were boys and eight were girls. Ten of the boys and four of the girls were found to be infested with one or more parasites.

The foregoing tables are more or less informative from a certain viewpoint, and the reader gains the general impression that infestation with intestinal parasites is accompanied, in a large proportion of cases, by certain phenomena. General impressions of this nature, however, are not particularly satisfactory as a basis for diagnosis or treatment. The reader cannot fail to notice the rather striking similarity in the picture presented by individual and collective infestations with the helminths, but he will seek in vain for any manifestation that will point unerringly to infection with any particular species. This is trite but none the less true. Variations in the severity of symptoms in practically similar combinations of parasites can, in many instances, be accounted for by differences in the intensity of infection; but this does not furnish an explanation in every case.

For the most part, effects upon the mental development and the nervous system seem not to be especially marked, but allowance must be made for the methods of estimating these that circumstances forced us to adopt. It is not unlikely that more exact methods would yield different results. The abdominal symptoms are, however, more suggestive and, in many instances, are rather striking. In as much as these findings are capable of interpretation from several different viewpoints, our inclination is to let the reader study the records and make his own interpretations, bearing in mind that only Filipino children are involved. Nevertheless, several points of general interest occur to us that it seems worth while to discuss.

INFECTIONS WITH PROTOZOA AND PARASITES OTHER THAN HELMINTHS

Spirochæta eurygyrata.—This parasite was first reported from the Philippine Islands by Crowell and Haughwout,(12) who found it in 73 per cent of a series of adult Filipino patients studied in the Philippine General Hospital. In the present series, it was detected in 61 per cent of the cases, the earliest infection having been found in a boy 7 months old. Spirochætes occurred to the exclusion of all other parasites in eight cases, none of them more than 2 years of age. Study of these cases as presented to us failed to yield any evidence on which to base an opinion regarding their harmfulness. We have noticed, however, that the spirochætes seem to flourish exceedingly in the fæces of patients suffering from bacillary dysentery or cholera. In such stools they are frequently present in enormous numbers, often appearing in tangled masses or agglomerations. We have in mind one particularly striking case of a male child, 5 years old, admitted with bronchopneumonia and showing meningitic symptoms and marked abdominal distention. Fresh preparations of the fæces were literally alive with spirochætes from 10 μ to 15 μ in length. Preparations kept in the moist chamber still showed actively motile spirochætes at the end of twenty-four hours. On the night following admission, the child had several convulsions and died in one of them. The case was looked upon with suspicion at the time, and autopsy and bacteriological examination showed the child to have died of Asiatic cholera. This case is not included in our series, however, for the reason that only one examination of its fæces was made. Several severe cases of ileocolitis showed the same luxuriant growth of spirochætes.

This parasite is of wide geographical distribution and frequent occurrence, and the tendency has been to regard it as nonpathogenic. Some writers, however, regard it with suspicion. Nevertheless, we believe that in some instances it may behave in a manner similar to that attributed to certain of the flagellated protozoa. Fantham(17) has described the penetration of shed epithelial cells from the intestinal wall by this spirochæte, adding that in this position the spirochætes sometimes produce their resting coccoid bodies. If this really occurs, there is ground for the belief that under certain conditions the spirochætes may penetrate the epithelial cells in situ and incidentally do damage to the mucous membrane.

Crowell and Haughwout have suggested that *Spirochæta*

eurygyrata may be a factor in a certain type of rebellious entamœbic dysentery which, while especially resistant to ipecacuanha and its derivatives, frequently yields to treatment with salvarsan.

"Blastocystis."—We include this organism in our report with some hesitation because of the lack of definite knowledge concerning its nature and significance. In as much, however, as neither has been determined, we thought it wise to make a record of our findings as a basis of comparison in future work. We encountered "Blastocystis" in thirty-four cases, but it occurred as an exclusive parasite in only one case. Stained preparations of these bodies were studied in every case to differentiate them from the "Iodine Cysts" of Wenyon and others, now regarded by Kofoid, Kornhauser, and Swezy(35) as the cysts of a large race of *Endamœba nana* (*Endolimax nana*), and the aberrant forms sometimes assumed by some of the other intestinal amœbæ of man. In view of the findings of Kofoid, Kornhauser, and Swezy in their excellent study of the "Iodine Cysts," we perhaps should have carried over our two cases of "I Cyst" infection to the *Endolimax nana* column. However, we satisfied ourselves beyond a reasonable doubt that none of the bodies we have classified under "Blastocystis" represent encysted stages or aberrant forms of any of the intestinal amœbæ, and there we leave them.

Entamœba histolytica.—No case of infection with this parasite was discovered in our series, and this we are inclined to regard as possibly of great significance. Another interesting thing was our failure to observe Charcot-Leyden crystals in more than one case. We observed them once only, in the fæces of a 12 year old girl whose stool was positive for "Blastocystis," *Spirochæta eurygyrata, Trichuris,* and hookworm. In view of the recent work of Acton(1) on Charcot-Leyden crystals in the fæces, we made a particularly thorough study of this case without, however, discovering either the cysts or trophozoites of *Entamœba histolytica.* Acton has shown that there is a very high degree of association between these crystals and *Entamœba histolytica,* and he lays considerable stress on them in connection with the laboratory diagnosis of entamœbiasis; for they are, according to his figures, rarely found in other infections. Castellani has reported them as occurring in ancylostomiasis, and it should be noted that our case was infected with hookworm. The crystals found in this case were of the shorter type that Acton designates as characteristic of

chronic and carrier cases, and it may be that this case was a carrier. Acton states that the crystals may persist in the stools for some time following treatment when the encysted amœbæ have disappeared. Inquiry into the history of this case, however, failed to develop any evidence of dysentery, which, nevertheless, does not necessarily establish a clean bill of health for the child.

Matthews and Smith,(40) in their recent paper, have shown a rather low incidence of *Entamœba histolytica* infection in five hundred forty-eight Liverpool children, only 1.8 per cent of whom were infected with the organism. They found 11.1 per cent infected with *Entamœba coli* as against 7 per cent in our series, and 2.7 per cent *Endolimax nana* infections as contrasted with our 7 per cent. Yorke(56) in a study of autochthonous entamœbic infections in England and Wales, examined the stools of two hundred forty-six children under 12 years of age. Cysts of *Entamœba histolytica* were found in only 0.8 per cent, and cysts of *E. coli* in 10 per cent of the subjects. Out of fifty cases of colitis of various types found by Mendoza-Guazon(43) in her post-mortem studies of one thousand Filipino children under 5 years of age, only one was of the amœbic type.

Recently the incidence of bacillary dysentery in Manila has considerably overshadowed entamœbiasis as judged by the cases that have come under our observation; nevertheless, entamœbiasis is of frequent occurrence among adults of all races, and there is no reasonable doubt that the opportunities for infection with this organism are as good in the case of children as they are with adults. There would seem to be ground for the belief that the obligatory tissue parasites among the protozoa, such as *Entamœba histolytica* and *Balantidium coli*, for some reason or other, find the conditions in the juvenile intestinal tract unsuitable and rarely succeed in establishing themselves there. This is a matter that we believe should be given the most careful study—first of all to determine if such is actually the case and, if so, why. We hesitate to believe that the intestinal mucosa of the child affords a more effective mechanical barrier than that of the adult. It certainly does not seem to in the case of the helminths. We venture to suggest that the key may be found in the physiology of the child—possibly in the secretion of some endocrinal gland that functions with greater activity in childhood than it does after adolescence and which may, in some way, exert an inhibitory influence on the growth and development of certain tissue-dwelling organisms.

It is suggested that the solution of this question may lead to a new line of therapeutic attack in the treatment of entamœbiasis in adults.

Entamœba coli.—As has been said, this parasite was found in 7 per cent of our cases, appearing for the first time between the ages of 2 and 3 years. The infections for the most part were rather light and do not seem to merit discussion here.

Endolimax nana.—This parasite likewise yielded 7 per cent infections in the series. It appeared in one case between the first and second year, but other cases were not encountered until the sixth year.

This parasite was first observed by the senior author in the fæces of a colleague in 1914. At that time he referred it provisionally to the genus *Vahlkampfia* and regarded it as a free-living species that had strayed from its accustomed path. The infection persisted, and the organism was given further study and compared with several other amœbæ parasitic in lower animals, having nuclei of the "limax" type. Before the study was completed Wenyon and O'Connor published their description of *Entamœba nana,* and pressure of other work necessitated the abandonment of the study. Since then he has observed this organism frequently in the stools of Americans and Europeans, but it is only recently that he has begun to find cases among the Filipinos. The apparent preference of *Endolimax nana* for white-skinned hosts was very puzzling until it developed that there was no descrimination on the part of the organism.

Dientamœba fragilis.—This organism, encountered in 3 per cent of our cases, did not put in an appearance until the eighth year. Once it was associated with *Endolimax nana.* This parasite was first seen by one of us (F. G. H.) in the fæces of an American woman residing in Manila, shortly after Jepps and Dobell(33) published their paper on *Dientamœba fragilis.* So far it has been found in Manila in five cases, one American and four Filipinos, two of them being adults.

Kofoid, Kornhauser, and Place(34) have recently reported this amœba in two cases. One case was that of a soldier on overseas service, and the other a soldier on home service in the United States. This extends the distribution of the parasite from England to the United States and through to the Philippine Islands. Jepps and Dobell's paper suggests that the distribution may be even wider than this. Probably *Dientamœba fragilis* has been mistaken for *Endolimax nana* in many instances.

Four species of flagellated protozoa, representing four genera of the Polymastigida, were encountered in our series.

Trichomonas intestinalis.—This was the most frequently encountered flagellate. It was first seen in a child between 1 and 2 years of age. Thereafter it was distributed fairly uniformly through the series. It occurred ten times.

All of the trichomonads we encountered are referable to this species, careful study having failed to discover either *Tetratrichomonas* or *Pentatrichomonas.* A case of infection with *Pentatrichomonas* in a Filipino child has recently been described by Haughwout and de Leon(28) in which large numbers of the organisms were seen to contain erythrocytes apparently in various stages of digestion. The stool examined in that case contained immense numbers of intact erythrocytes (the child was suffering from ileocolitis) that were greedily taken up by the flagellates. The authors were inclined to regard the ingestion of the red blood corpuscles as indicating a certain degree of adaptation to tissue parasitism. In view of this we examined our *Trichomonas* cases with especial care, but notwithstanding they occurred, in some cases, in stools containing free erythrocytes, in no instance did we find flagellates that had ingested corpuscles.

Yorke and Macfie(57) have recently published a note in which they describe the phagocytosis of erythrocytes by an amœba of the *Vahlkampfia* or "Limax" type which they obtained from human fæces. In so doing they cast a doubt on the validity of the conclusions of Wenyon and O'Connor that the presence of phagocytized erythrocytes is diagnostic of *Entamœba histolytica.* It must be admitted that the experiments of Wenyon and O'Connor on *Entamœba histolytica* and *Entamœba coli* were scarcely extensive enough to justify sweeping generalizations, but we incline to the opinion that while the ingestion of erythrocytes by different organisms is interesting and suggestive, still, it is important to discover whether or not the corpuscles are *digested.*

Marty[4] has described a case from the Congo the fæces of which contained spirochætes, *Giardia,* and amœbæ, some of which contained red corpuscles and some of which did not. The case was treated with subcutaneous injections of emetine, and according to Marty the amœbæ that did not contain red corpuscles, the spirochætes, and *Giardia* were unaffected, whereas the amœbæ that contained erythrocytes disappeared. This

[4] Bull. Soc. path. exot. 10 (1917) 539.

brings recollection of the statement of Escomel [5] who concluded that *Entamœba histolytica* will not engorge the red corpuscles of a person taking emetine, but will readily engorge those of a normal person. He gathered from this that emetine renders the erythrocytes unpalatable to *Entamœba histolytica.* This is scarcely more convincing than the other observations cited. Nevertheless, we believe that further work is needed to establish or disprove the diagnostic value of ingested corpuscles in the entamœbæ. For the present we shall continue to lay due stress on the presence of ingested corpuscles in the cytoplasm of intestinal amœbæ. In connection with the trichomonads observed in this series we may say that we frequently encountered individuals that had engorged bacteria, a thing that was not observed by Haughwout and de Leon in their pentatrichomonads.

The trichomonad infections seen in this series gave us no evidence of the pathogenicity of the organism, either microscopically or clinically. The flagellate occurred to the exclusion of other parasites only once. This was the case of a boy between 6 and 7 years of age (No. 12), who was suffering from ileocolitis and tuberculosis. While the symptoms may have been wholly referable to the ileocolitis, it was noted that the abdominal pain, which was fairly constant, even when the stools were not being passed, was of extraordinary severity. The first stool that was examined was watery, feculent, and gave off a very foul odor. It was full of necrotic cellular débris and erythrocytes, and the flagellates were present literally in swarms. Notwithstanding the conditions for the ingestion of erythrocytes seemed ideal, no trichomonad was seen that contained a blood corpuscle. Many were seen that contained bacteria. This is in striking contrast to the observations of Haughwout and de Leon in the case of *Pentatrichomonas.*

The ileocolitis in this case ran a very stormy and protracted course but eventually terminated in recovery. Were it not for the complicating tuberculosis and the poor general condition of the patient as a whole, we should be inclined to lay considerable stress on the superimposed flagellate infection on the dysentery, especially in view of the protracted course of the disease.

Giardia intestinalis.—This organism first appeared in the stool of a child between the third and fourth years. Only one of the eight cases found produced the flagellated trophozoites

[5] Bull. Soc. path. exot. 8 (1915) 573.

in the stools. Diagnosis of the other cases was made by means of the cysts. Considerable variation was noted in the size of the cysts in some of the cases, which suggests that there may be two or three local strains or races—possibly with varying degrees of virulence. Our figures of incidence are lower than those of Liverpool children as recorded by Matthews and Smith,(40) who found 16.4 per cent in children between 1 and 5 years of age, and 14.3 per cent in children 5 to 12 years old.

The case in which the *Giardia* trophozoites appeared in the stools was of some interest. It was presented by a boy 7 years old who had been suffering from a severe and protracted attack of ileocolitis. Previous to its onset he had vomited ascarids. The stool was examined for the first time on August 21. It was soft and yellow, and beyond the presence of the ova of *Trichuris* nothing especially noteworthy was seen. Concentration of this stool showed a heavy infestation with *Trichuris* and nothing more. The same observations were made when the stool was again examined on August 23.

On August 26, however, the stool was diarrhœal, and large numbers of *Giardia* trophozoites and cysts were present. Something apparently had happened to the flagellated forms for they were practically nonmotile, and those that showed any signs of life were sluggish and moved about as if they were waterlogged. "Blastocysts" were found in considerable numbers; also *Entamœba coli*, some of which had engulfed small "blastocysts." The following day both the trophozoites and cysts of *Giardia* were absent from the stool and they did not appear again during the time the child was under observation. This child was heavily parasitized with both protozoa and helminths; and it is, of course, impossible to fasten the blame for persistent abdominal pain, before the onset of the dysentery, on any particular one of them. We are inclined to believe that the pain, which was complicated at times by distention and tympanism, was stirred up by the *Trichuris* infection.

Case 84, a boy 10 years of age, gave a history that might be referred to *Giardia*. The child came into the hospital suffering from tetanus and an infected wound of the right foot. He received antitetanus serum and recovered. The stools were markedly diarrhœal and contained *Spirochæta eurygyrata* and cysts of *Giardia*. The patient gave a history of occasional abdominal pain but had never passed or vomited worms. No helminth ova were found. The general physical and mental

make-up of the child was good. The other cases in which *Giardia* were found were so parasitized with other organisms as to render it futile to speculate upon them.

We are inclined to regard this organism as potentially harmful, particularly in children. Much has been written concerning it; but we lay considerable stress on the views of Fantham and Porter,(18) who have studied it experimentally in animals as well as clinically in man. They conclude that the organism is pathogenic to man and is capable of producing diarrhœa that may be persistent or recurrent. They also state their belief that the virulence of the parasite varies.

Mantovani(38) takes a rather extreme view of the case, however, in reporting symptoms which even included ulceration of the rectum. His patients exhibited tenesmus and passed as many as thirty or forty stools a day. We have seen nothing of the kind in our experience, and we are inclined to attribute the tenesmus and ulceration about the rectum to something else, especially in view of the fact that *Giardia* is normally an inhabitant of the small intestine. The unencysted forms are seldom encountered so far down in the intestine as the rectum. We have seldom found unencysted forms in the fæces.

Eutrichomastrix sp. (?)—A single individual was found in the examination of fresh preparations in one of our cases. We failed to find others on repeated examination of the stool or the stained preparations.

This parasite was not discovered until the second stool was received in the laboratory. At first it was thought that the organism belonged to the trichomonad group, and it was carefully followed for upwards of half an hour to discover if it would ingest any of the erythrocytes that were present in large numbers in the stool. It did not. Gradually it became apparent that what at first had been regarded as an undulating membrane with its marginal flagellum was, in reality, a free flagellum of prodigious length directed downward and backward in heteromastigote style. Careful scrutiny showed that the organism possessed three anteriorly directed flagella and a posterior projection that we interpreted as an axostyle. We were unable to determine with certainty whether or not there was a cytostome.

We regard it as possible that this organism was identical with the flagellate described by Chatterjee(7) under the name *Trichomastix hominis*. However, there is room for some doubt here, and we wish to be understood as only provisionally placing

this organism in the genus *Eutrichomastix*. This genus has been defined by Chalmers and Pekkola(6) as follows:

Eutrichomastix Kofoid and Swezy 1915.

Parasitic Tetramitidae with an axostyle and a cytostome, without thickened lips and with three anterior and one free trailing flagellum, but without an undulating membrane or contractile vacuole. *Type species: Eutrichomastix lacertae* (Blochmann 1884), found in the intestine of *Lacerta agilis*.

Chatterjee, in describing the organism seen by him, says that in some individuals "a small dark line is seen originating from the nucleus and ending in the posterior end." However, he states that neither cytostome nor any axostyle-like organ could be made out, and speaks of the rather close resemblance between his organism and Aragao's *Copromastix prowazeki*.(4)

Chatterjee's parasite was found in the stool of a dysenteric patient. No amœbæ were found in the stool. Our patient, a girl aged 10 years, was suffering from a mild ileocolitis from which she recovered. Her stools were fluid, feculent, and contained necrotic cell débris, cast-off epithelium, and erythrocytes. Other parasites present were "Blastocystis," *Trichuris*, *Ascaris*, and hookworm. Abdominal symptoms exhibited before the onset of the ileocolitis are probably attributable to the other parasites present.

In discussing the genus *Trichomastix*, in which Chatterjee, following Parisi, placed his organism in 1917, Chalmers and Pekkola, writing in 1918, point out that the name was preempted in 1878 by Vollenhoven for the hymenopteron *Trichomastix polita*, which, of course, supersedes Blochmann's designation for the protozoön in 1884. Raillet altered the spelling to "Trichomastyx" in 1893; but Chalmers and Pekkola consider the alteration insufficient, so they adopt the generic name *Eutrichomastix* proposed by Kofoid and Swezy in 1915,(36) though expressing a preference for their own name *Axomastix* as establishing a greater distinction between the hymenopteron and the protozoön.

Chilomastix mesnili.—Under the generic names *Tetramitus* and *Macrostoma*, this parasite has been reported several times in the Philippines. Apparently it does not occur with great frequence. Three cases were found in our series. In one the diagnosis was made from the free-swimming trophozoites, and in the other two the diagnosis was made by discovering the encysted forms on the stained preparations. It never occurred as an exclusive parasite. Its earliest appearance was between the second and third years.

No sporozoan or ciliated forms were encountered in the series.

HELMINTHAL INFECTIONS

The infestations here were exclusively confined to the Nematoda, not a single case of infection with either the Cestoda or the Trematoda having been discovered. This is probably attributable, in a large degree, to the small number of cases that form this series, for nearly all the workers in the past who have conducted inquiries into the incidence of intestinal parasites in the Philippines and who have dealt with larger numbers than we, have discovered representatives, in small numbers, of both groups. *Tænia solium* and *Tænia saginata,* as well as *Hymenolepis nana,* have been reported by various observers; and Mendoza-Guazon(42) has reported on the finding at autopsy of an infestation of a child with *Dipylidium caninum.* Garrison(22) and Hilario and Wharton(31) have reported cases of infestation with the trematode *Echinostoma ilocanum* in Filipinos from the northern provinces. Other trematode infections have been reported from the southern provinces. The occurrence of trematodes in Filipinos residing in the neighborhood of Manila would seem to be exceedingly rare. The senior author has encountered several cases of infection with *Schistosoma* and *Clonorchis* in Manila, but in each case the patient was either a Chinese or a Japanese who, without much doubt, had contracted the infection before coming to the Philippine Islands. He has never seen such a case in a Filipino.

Trichuris trichiura.—If our series is a criterion, and we believe that it is, this is the most prevalent animal parasite occurring in children in and about Manila. It was found in 69 per cent of our cases. Of these thirty-three were male and thirty-six female. This shows a slight preponderance of infections in girls over those occurring in boys, which is in accord with the previous findings of Garrison and Llamas,(23) Garrison,(21) Musgrave and Clegg,(45) and other investigators.

High as our figures are they are considerably under those reported by Garrison and Llamas in their examination, made in 1909, of one hundred fifty-eight children living in Manila in whom they found an incidence of *Trichuris* infection amounting to 92 per cent. These authors do not state the age incidence in their cases, so we are left in doubt in our efforts to make a comparison; but knowing as we do that some of the earlier workers laid little stress on the examination of breast-fed and very young children, assuming that they were unlikely

to be infected, we think it possible that their study did not include children under 2 years of age as ours did. However, it will be seen, from a study of the data in connection with Tables 9 and 10, that breast-fed and bottle-fed children are not necessarily free from intestinal parasites. Furthermore, our series of one hundred children included twenty-eight who were not more than 2 years old, and on excluding them from our series we find an incidence among the remainder of 86.1 per cent, which is not far under the figure of Garrison and Llamas.

It is interesting, in this connection, to recall that Musgrave and Clegg encountered several *Trichuris* infections in breast-fed children, and they report on the case of a child 3 months old that was infected with this parasite.

While considering these figures it is also interesting to note that those of Garrison and Llamas for *Ascaris* are identical with ours (56 per cent), while they show 11 per cent hookworm incidence as compared with 12 per cent in our series.

In contrast to the above are the figures quoted by Willets(55) for *Trichuris* infections occurring among children residing on the tobacco plantations of the Cagayan Valley. Willets has tabulated the age incidence of these infections from children under 1 year old up to those between the ages of 10 and 14 years. No infections with *Trichuris* were discovered until the second year, when these parasites were encountered in 3.26 per cent of the children examined. The incidence reached its maximum between the seventh and ninth years with 8.8 per cent infections. Between the tenth and fourteenth years this had fallen to 7.68 per cent. Most of the infections he encountered were light. He attributes this low incidence to lack of introduction of *Trichuris* in great numbers to the haciendas and cites evidence in suport of this view.

Garcia,(20) in reporting on the intestinal parasites of ninety-eight children in the Southern Islands Hospital at Cebu, found *Trichuris* in 44.08 per cent of the cases. He qualifies his report, however, with the explanation that his figures probably represent the minimum for they are based on the examination of only "two or more cover-glass preparations."

Crowell and Hammack,(11) in a study of the intestinal parasites encountered in five hundred autopsies in Manila, found *Trichuris* in only 34 per cent of their subjects. They included adults and excluded children under 3 years of age, and their study did not include the microscopic examination of fæces.

In our series *Trichuris* occurred as the only helminth present in thirteen cases. Five of these gave no history of abdominal

discomfort or pain; seven gave histories of abdominal pain, distention, or diarrhœa, or combinations of the three; and one gave a history of distention, tympanism, and vomiting. One of them gave a history of attacks of vertigo. Three of the thirteen cases were infested with *Trichuris* to the exclusion of all other parasites. The salient features of these cases were as follows:

Case 10. Under treatment for ileocolitis. Gave a history of occasional abdominal pain before the onset of the ileocolitis.

Case 56. Under treatment for acute bronchitis. The child was emaciated. It gave a past history of abdominal distention, tympanitis, and vomiting. It had suffered from nervous irritability and insomnia.

Case 97. Under treatment for ileocolitis. Had suffered in the past with occasional abdominal pain and had spontaneously passed *Ascaris* in the stool before admission to the hospital. The child had once fainted without apparent cause and for a long time had been subject to attacks of sweating. It had shown a progressive loss of appetite and a slowing down of its activities before the attack of ileocolitis. In the hospital the stool failed to show the ova of *Ascaris* or any parasite except *Trichuris*.

When this study was undertaken we planned to make total and differential blood counts and hæmoglobin estimations of all the cases, but pressure of other duties and other circumstances prevented us from carrying this out. We were able to make only a few differential counts—and those of one hundred cells only. Unfortunately the three cases noted above received no blood examination. This is greatly to be regretted, for they afforded the only material available to us for recording the eosinophilia in pure infections with *Trichuris*.

Five of the cases in which *Trichuris* was the sole helminth present were examined and yielded the following percentages of eosinophile leucocytes: No. 4, 9 per cent; No. 14, 4 per cent; No. 20, 2 per cent; No. 29, 3 per cent; No. 30, 2 per cent.

Thirteen cases of mixed *Trichuris* and *Ascaris* infections gave eosinophile counts ranging from 0 to 5 per cent.

One case of mixed *Trichuris* and hookworm infection gave 6 per cent eosinophiles.

Three cases of mixed *Trichuris, Ascaris,* and hookworm gave the following eosinophile percentages: No. 9, 4 per cent; No. 22. 3 per cent; No. 79, 0.

One case of uncomplicated hookworm infection gave an eosinophile count of 12 per cent, and one of *Ascaris,* a count of 2 per cent.

We do not wish to be understood as generalizing on the above data; but we would suggest, as have other investigators, that the whole subject of eosinophilia in its relation to parasitic infestations needs thorough reinvestigation at the hands of competent parasitologists and hæmatologists. We believe that entirely too much has been taken for granted regarding the eosinophile count.

Notwithstanding these particular observations, as included in our series, give us really very little *definite* basis for conclusions, we regard *Trichuris* as a parasite that is potentially harmful. In itself we regard it as dangerous, while we think our data show that its partnership with *Ascaris* constitutes a combination that is decidedly inimical to the comfort and welfare of children at least. While we are not entirely prepared to concur unqualifiedly in the views of Strong(51) who says that "the symptoms and sign of trichocephaliasis are practically identical with those of ankylostomiasis, the only difference being that of severity," still we believe his statement furnishes food for serious consideration. At the same time we must bear in mind that Strong was dealing with American children, while all our patients were Filipinos. This is a distinction that may be found to form the basis of the difference of opinion between Strong and ourselves. Strong cites five cases in which he contends that *Trichuris* "can give rise to very annoying and even severe symptoms such as severe anæmia, dirt eating, etc." He adds that eosinophilia is of constant occurrence and lymphadenopathy is fairly frequent just as in ankylostomiasis and ascariasis." [6]

[6] Apropos of Strong's statements is a case in which the senior author was consulted just as this paper was being written. It was presented by an American boy, 2 years old, anæmic and more or less emaciated. The child was nervously irritable and generally run down, and was about to be sent into the hills for recuperation. When the stool was first examined, it was impossible to apply the cover glass closely to the preparation on the slide because of an accumulation of grit and dirt contained in the fæces. The mother was questioned, and she said that it was practically impossible to prevent the child from eating dirt. She said that unless he was watched carefully he would take dirt from the flower pots on the porch and swallow quantities of it. Hookworm was, of course, suspected, but repeated concentration of the stool failed to yield the ova. There was, however, a massive infection with *Trichuris*, an infection with *Trichomonas*, and a few unfertilized *Ascaris* eggs were found in one of the centrifuged specimens. In the absence of any effective treatment for *Trichuris*, and in view of the poor physical condition of the patient, we bespeak a rather trying period in the life of this young man.

Da Matta(13) has reported two rather interesting cases of *Trichuris* infection in young children that were associated with fatal results. They were encountered in a study of helminthal infections in a large series of children at Manaos, during which he found an incidence of *Trichuris* infection amounting to 82.3 per cent.

The first case was in a child 4 years old, very pale and œdematous. The total erythrocyte count was 580,000; eosinophiles, 14.3 per cent. The hæmoglobin was 15 per cent. The stools showed numerous ova and abundant mucus. There was hyperalgesia of the skin—marked over the cæcum and colon. At autopsy two hundred ninety-five *Trichuris* were found in the colon.

The other case was that of a child 8 years old. At autopsy eleven *Trichuris* were found in the lumen of the appendix attached to the wall, while one hundred nine were collected from the cæcum.

Musgrave and Clegg,(45) in their paper on trichocephaliasis, report four cases, including two fatal cases, in which *Trichuris* seemed to play a rather important part. The blood pictures were particularly interesting, showing low erythrocyte counts and hæmoglobin percentages of 20 to 36. Eosinophilia was incompletely reported. In one case that went to autopsy, numerous *Trichuris* were found in the small intestine—mainly the ileum—and two hundred were found in the large intestine. In another case death was caused by an embolism of the left coronary artery caused by a *Trichuris,* the posterior third of which remained free in the aorta.

Musgrave and Clegg express doubts as to the commensal nature of *Trichuris* and suspect it to be pathogenic. Crowell and Hammack,(11) however, in their autopsy studies, report their failure to find tangible evidence of the pathological effects of *Trichuris.*

Ascaris lumbricoides.—As has been stated this parasite occurred in 56 per cent of our cases. Of these, twenty-four cases were found in boys, and thirty-two in girls. Garcia, in his Cebu series, found 42.85 per cent of the ninety-eight children he examined infected with *Ascaris.* Willets found that in Cagayan Valley the *Ascaris* infections in children ranged from 15 per cent in children under 1 year, up to 69.9 per cent between the ages of 10 and 14 years. Garrison's series of Bilibid Prison adults yielded only 26 per cent infections, but the group was composed of persons coming from many widely separated

parts of the Archipelago and possibly gives a fair idea of the adult distribution of *Ascaris* in the Philippine Islands. It has been the general impression among microscopists in Manila that *Ascaris* occurs almost twice as frequently in children under 15 years of age as it does in adults in middle life.

In this series, at least, it is rather hard to consider *Ascaris* and *Trichuris* infections apart from one another. The two parasites occur together with great frequency, and their association seems to be accompanied by a fairly recognizable train of symptoms referable to the abdomen, such as pain, distention, tympanism, and frequently the vomiting and passage of *Ascaris* or both vomiting and passage of the worms.

This combination of parasites is one that may be expected to keep the greater portion of the entire intestinal tract in a state of chronic to acute irritation—mechanical as well as chemical. *Ascaris* lives in the small intestine, but it is a confirmed nomad—something of an explorer—and its wanderings frequently take it from end to end of the small intestine and occasionally into the stomach, the liver, and other places where it properly has no business. Not infrequently it rubs elbows with the hookworm. Such a condition may well be held to account for considerable trouble in the small intestine; when there is added to this the irritation produced in the large intestines by the presence of numerous *Trichuris* which may even invade the appendix, and in rare instances the ileum, it will be seen that the involvement of the digestive tract is fairly complete from end to end. It is in cases such as these that we frequently encounter more or less severe abdominal pain, distention, and either the vomiting or the passage, or both, of worms when no treatment whatever has been instituted to bring about the expulsion of the parasites. In connection with this it is interesting to review some of our *Ascaris* cases.

These two cases were infected with *Ascaris* to the exclusion of all other parasites: Case 43, male, 21 months old. The patient was under treatment for bronchopneumonia. He gave a history of occasional flatulence. Case 99, female, 2 years old. The patient was under treatment for indigestion. The child gave a history of having suffered from abdominal distention. Mentally, the girl was backward and did not talk. In both these cases it will be noted that the abdominal symptoms were decidedly mild.

The following cases, also, are rather interesting:

Twelve cases of *Ascaris* infection in which the patients gave no history of abdominal disturbances:
- Unaccompanied by other helminths, 2.
- Accompanied by *Trichuris*, 8.
- Accompanied by *Trichuris* and hookworm, 2.

These five cases of *Ascaris* infection gave a history of tympanitis and distention:
- Unaccompanied by other helminths, 3.
- Accompanied by *Trichuris*, 2.

Abdominal pain was a prominent feature of the following twenty-five cases of *Ascaris* infection:
- Unaccompanied by other helminths, 3.
- Accompanied by *Trichuris*, 21.
- Accompanied by *Trichuris* and hookworm, 1.

Abdominal discomfort or pain accompanied by the vomiting of *Ascaris* occurred in these eight cases:
- Accompanied by *Trichuris*, 7.
- Accompanied by *Trichuris* and hookworm, 1.

Abdominal discomfort or pain accompanied by the passage of *Ascaris* occurred in these thirteen cases:
- Unaccompanied by other helminths, 1.
- Accompanied by *Trichuris*, 8.
- Accompanied by *Trichuris* and hookworm, 4.

In only one case in the last two groups did *Ascaris* occur to the exclusion of other helminths. Contrast these with cases 43 and 99. In other words, with an increase in the severity of the abdominal symptoms there seems to be a tendency toward a falling off of solitary infections with *Ascaris*. With this appears a corresponding rise of the association with *Trichuris* to the extent that one strongly suspects that the combination of pronounced abdominal symptoms and the spontaneous expulsion of *Ascaris* is frequently the expression of a coexisting infection with *Trichuris* and possibly attributable to it.

A clinical diagnosis of ascariasis was made by the admitting physician in several of our patients before the stools were examined. It is interesting to note that *every one of these cases*, twelve in number, *was positive for Trichuris as well as Ascaris*. These cases were numbered 6, 9, 15, 18, 20, 29, 39, 48, 60, 69, 72, and 81. Case 29 passed *Ascaris* in the stool before admission to the hospital, and its fæces were negative for the ova when examined by us.

Such data are, of course, only suggestive, but the cases are those that seemed to show symptoms sufficiently characteristic to justify the admitting physician in making a diagnosis of ascariasis without waiting for the laboratory report. In some cases there was a history of the passage or vomiting of worms

before admisison, but not in all. Bearing on this are a few cases that came to our attention, where outside physicians had ordered heavy doses of santonin that had been administered without bringing about the expulsion of any worms, the explanation being very simple—there were no worms there to expel. These cases were all negative for the ova on examination by us. In proper hands, santonin is a safe drug, but we believe its administration for the purpose of making a therapeutic diagnosis of ascariasis should be discouraged. Except for those rare, almost theoretical, cases where male worms only might be present, it is exceedingly likely that a laboratory diagnosis could certainly be made in every case. Furthermore, we are growing to place less and less reliance on santonin in the treatment of ascariasis and recently one of us (F. S. H.) has undertaken a study of the action of oil of chenopodium in these infections with results that are, so far, quite satisfactory.

We observed twenty-five cases that gave a history of having vomited or passed, or passed and vomited, ascarids before admission to the hospital. None of these cases had received anthelminthic treatment, so the occurrence cannot be attributed to the action of santonin. All of these cases underwent our series of examinations, and eight of them were found to be negative for the ova of *Ascaris*. In other words it would appear that eight of the patients had purged themselves of their roundworm infections. We think it extremely likely, however, that they have contracted new infections of *Ascaris* since then.

Four of these cases vomited the worms. Of these, two were negative and two positive on microscopical examination.

Sixteen patients passed the worms, and of these, five were negative and four positive on microscopical examination.

Five patients both vomited and passed worms. On microscopical examination one was negative and four were positive.

In the hospital eight patients either vomited or passed worms. Of the four that vomited them, one was negative for the ova on microscopical examination, and one was found negative out of the four that passed ascarids. These are the two cases that were missed microscopically and diagnosed in the ward. Unfortunately, the worms were not saved by the nurse, hence we are unable to state that they were males in extenuation of our failure to diagnose the infections in the laboratory. We might add in connection with these eight cases that some of the patients had received santonin and calomel, so that the ex-

pulsion of worms cannot be said to have been spontaneous in all cases, as was the case with the others.

Ascaris, in recent years, has been steadily losing its reputation for harmlessness. Unfortunately, much of the evidence against it has been accumulated on the operating table and at autopsy. We now know it as a not infrequent cause of intestinal obstruction. Perforation of the intestine has been traced to it in some cases, and invasion of the bile ducts, the liver, and the appendix are not uncommon. More than one foreign physician we have known has received a shock during his early days in the Philippines by witnessing "vermiform movements" of an appendix he has been called upon to remove. Degorce(14) has recently reported the formation of calculi in the bile ducts about the eggs of *Ascaris*.

A new phase of the mischievous activities of *Ascaris* has recently been suggested as a result of the brilliant work of Stewart and others on the life history of this nematode. It would be out of place here to go into details regarding the complex, devious, and seemingly anomalous developmental cycle of this organism described by Stewart and apparently sustained by other workers. As we have said, *Ascaris* is a nomad and there seems at present no reason to doubt that in its larval stages *Ascaris* penetrates the intestinal wall, travels through the blood stream to the lung, remains there for a while, and ultimately regains the intestine via the trachea, mouth, and œsophagus.

The thing that interests us most at this time is the possibility that in its peregrinations the worm, small as it is in this stage of its development, may cause serious trouble en route. This is a problem that is worth the most careful investigation, but it is a problem that it seems to us will be extremely difficult to handle on anatomical grounds alone.

Several investigators have observed lung symptoms in experimental animals following the ingestion of developed *Ascaris* eggs and they are exceedingly suggestive. These observations, however, have not been confined to lower animals. Mosler(44) and Lutz(37) have reported the observation of symptoms referable to the lungs in human beings a few days after the ingestion of the eggs of *Ascaris*. Lutz's experiment is of particular interest. He administered ripe eggs of *Ascaris lumbricoides* to a woman aged 32 years following which the woman suffered an unusually severe bronchitis accompanied by a slight remittent fever.

Pantin [7] reports an incidence of 100 per cent *Ascaris* infections in Kien Province, China. She describes a "wormy" cough that is not uncommon in the more heavily infected. She has noted, further, that bronchitis in children is cured by doses of santonin and aperients without the use of expectorants. If such a connection could be established it would appear to indicate that this was not due to the migration of the larvæ through the lungs, for it is scarcely to be expected that this treatment would be effective in the lung stages.

Ransom and Foster,(48) in an exceedingly readable paper written shortly before the untimely death of Foster, have summarized the present knowledge of the life history of *Ascaris*. In the course of this paper (p. 98), they say:

* * * In addition to the likelihood that Ascaris infection will be found to be responsible for certain lung troubles in human beings, particularly in children, it is quite likely that Ascaris has something to do with many of the cases of lung disease in pigs. Large numbers of young pigs suffer and die from lung affections the causes of which have never been satisfactorily explained. The symptoms shown by the experimentally infected pigs at the time of the invasion of the lungs by the larvae are frequently exactly similar to those exhibited by pigs suffering from so-called "thumps," a popular name for a serious condition of very common occurrence among pigs, and it is accordingly not improbable that Ascaris is an important factor in the production of "thumps," especially when it is considered how very commonly Ascaris occurs as a parasite of pigs. Though we can not yet form a true estimate of the actual importance of Ascaris as a cause of lung disease it is evident that this parasite has capacities for harm not formerly suspected. Stewart's very interesting discovery of the migration of the larvae through the lungs has therefore not only added materially to our knowledge of the life history of Ascaris, but also by opening up a new line of investigation in pathology is likely to lead to a better understanding of the cause, prevention and treatment of certain diseases of the lungs.

Out of the one hundred children studied by us in this series, thirty-three were admitted to the hospital for treatment of diseases of the respiratory tract other than tuberculosis, influenza, or pleurisy. The distribution of these cases is shown in Table 22.

TABLE 22.—*Respiratory diseases in the series.*

	Cases.
Bronchitis	11
Bronchopneumonia	12
Lobar pneumonia	9
Asthma	1
Total	33

[7] Pantin, Mabel, Brit. Med. Journ. Sept. 14 (1918) 287.

This is rather a large proportion of diseases of a certain type to occur among the admissions to a general medical service, but it is a fair index of the prevalence of respiratory diseases among Filipino children. All are exceedingly prevalent, and tuberculosis is a veritable scourge in the country.

We encountered twelve cases of tuberculosis in our series. Six of these were diagnosed as tuberculosis of the peribronchial glands, and six as pulmonary tuberculosis. We do not wish, at this time, to be understood as attempting to explain tuberculosis in Filipino children as developing from early *Ascaris* infections; the time is not ripe for that. Mendoza-Guazon,(43) in her study of the autopsy findings in Filipino children under 5 years of age, reports bronchopneumonia in 18 per cent of her cases, and lobar pneumonia in 3.6 per cent. Her tuberculosis findings were 8 per cent. She calls attention to the fact, which Musgrave and Sison have indicated, that among the Filipinos "infection among children probably is much below that in adults, because many die before the first year of life and no doubt before tuberculosis has been contracted or has developed to a degree sufficient for recognition."

Mendoza-Guazon also draws attention to the views of Rothe(49) and Dunn,(16) who believe that the respiratory tract is the usual entrance of tubercular infection in children.

On the whole, however, it seems better not to carry pulmonary involvement in ascariasis beyond the pneumonias and bronchitis until we have more definite knowledge than we now have. Furthermore, discussion on the basis of the incidence of pulmonary diseases in children in the United States can scarcely be said to promise much along these lines until we have more reliable data regarding the incidence and distribution of ascariasis among the children of that country.

With all deference to the fallacy of concomitant variations, it would seem worth while seriously to inquire into the possible relationship between diseases of the respiratory tract and early infestation with *Ascaris* among Filipino children.

At the same time the situation presents interesting problems from the viewpoints of the parasitologist and the pathologist. Naturally, it occurs to the pathologist and clinician to inquire how many larvæ would be required to produce a definite, harmful reaction in the lungs. Apparently the lung stages of *Ascaris* do not exceed 2.5 millimeters in length. In other words they are exceedingly minute; but that, in itself, does not necessarily prove anything. The capacity of these larval forms to work

injury in the lung would seem to us to depend upon one, or a combination, of three factors: 1, The number of infesting worms; 2, their physiology—that is to say, the character of the substances, if any, eliminated by them in the lung and the general nature of their life there; 3, foreign matter, such as bacteria from the intestinal tract possibly brought in by them. In the human host it will likely be somewhat difficult to ascertain these facts.

In the feeding experiments carried out on lower animals in which lung symptoms such as pneumonia were seen to accompany the migration of the larval forms through the lungs, large numbers of eggs were administered in nearly every case and the resulting infections were, of course, correspondingly heavy. Furthermore, while fatal pneumonia is a frequent concomitant of early *Ascaris* infection in pigs, it must be remembered that the feeding habits of pigs are of a nature such as necessarily to bring about exceedingly heavy infections with any organism whose portal of entry is the alimentary tract.

Do human beings acquire the massive single infections with *Ascaris* that attend the above circumstances? We are inclined to believe that they do not. It must be admitted that hundreds of ascarids have been found in the intestinal tracts of human beings in individual cases, but in these instances it seems to us that the total number represents the accumulation of many successive infections and not a single massive infection. Therefore, it is to be supposed that the number of larval forms passing through the human lung at any given time is probably insufficient to give rise to serious trouble there as a result of purely mechanical irritation or injury to the tissues. If the observations of those who have reported pulmonary symptoms in man in the course of an early *Ascaris* infection are to be relied upon, we probably must seek the cause of the trouble in some other factor, and therein would seem to lie the basis of some interesting work for the future.

This introduces, of course, the question of immunity in *Ascaris* infections. It is held by some writers that a degree of immunity develops following an initial infection. The experiments of Yoshida(58) in connection with this are inconclusive, but cast doubt on the proposition. Yoshida quotes Stewart who claims to have immunized a rat by one infection with *Ascaris* larvæ. In a series of observations now being carried on by one of us

(F. G. H.) evidence is accumulating to show that immunity in man is, at least, not invariable.

The physiology of *Ascaris* has been looked into by several investigators, and much has been brought out that may be interesting in connection with the foregoing. Schwartz,(50) who has recently made an investigation into the nature of certain hæmotoxic substances in *Ascaris*, has reviewed the work of some of the other investigators. Hall(26) quotes Garin as stating that the nematodes of the digestive tract live in all cases at the expense of the wall of the intestine and not on the food to be found in the lumen of the gut. *Oxyuris* and *Ascaris*, he says, live on epithelial cells, and *Ancylostoma* and *Trichuris* on blood. The nature of the attack on the tissues by hookworms, he states, is mechanical; that of *Trichuris* is chemical. Crowell and Hammack cite the case of Albert and Mendoza(3) where a toxic action was attributed to *Ascaris*. They also cite Flury(19) who experimented on *Ascaris* recovered from the intestine of the horse and the pig.[8]

Flury succeeded in demonstrating volatile aldehydes of fatty acids; free valerianic, butyric, and other acids; alcohols and esters in the body substances and excretions of his ascarids. He was led to the belief that irritation of the intestinal mucosa and the nervous and other clinical symptoms of ascariasis could be attributed to these substances.

Haughwout(27) cites Gibson who believes that *Ascaris* may produce an antivitamine or growth-inhibiting substance. He quotes Gibson as follows:

> The existence of an anti-vitamine or at least of growth inhibiting substances formed by ascarids is suggested by an observation which I made in connection with some milk feeding experiments with puppies. In a series of five young puppies fed on cows' milk growth stopped in four of the animals when 44 days old. Following the administration of an efficient vermifuge, there resulted the passage of many ascarids from the four dogs in which growth had ceased. Growth was immediately reëstablished.

By kind permission of Professor Gibson and his collaborator, Dr. Isabelo Concepcion, we reproduce the growth chart of the above-mentioned dogs (fig. 1).

[8] *Ascaris suum* or *A. suilla*, of the pig, is morphologically indistinguishable from *A. lumbricoides* of man, and these species are looked upon as identical by many helminthologists.

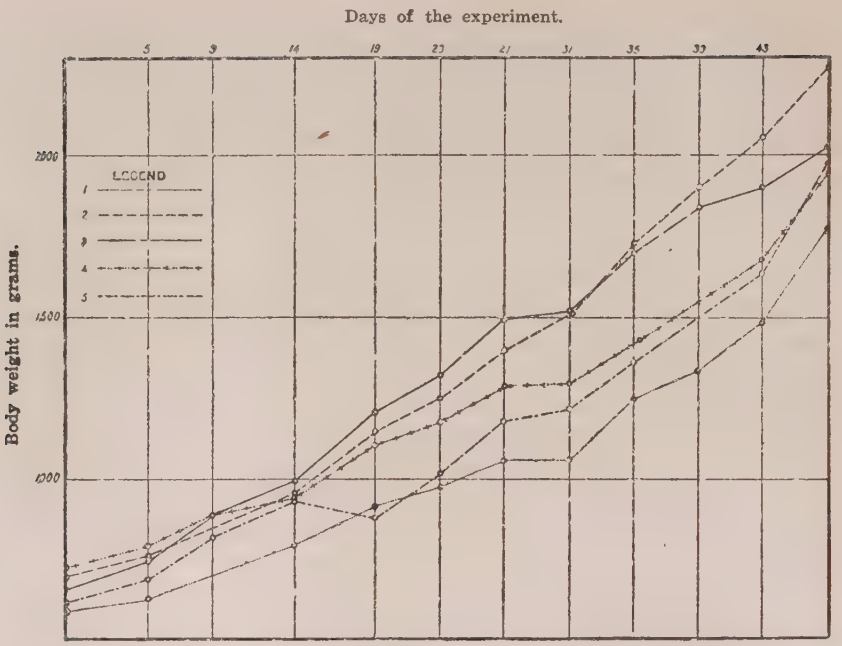

FIG. 1. Growth curves for dogs fed on fresh and autoclaved milk. Note the falling off of growth between the twenty-seventh and the thirty-first day. Note also that dog 2, which was not infected with *Ascaris*, continued to grow at about the normal rate.

The paper of Schwartz represents the most recent contribution to this subject that is accessible to us. Among the other conclusions he has drawn from his experiments are the following:

The failure to demonstrate hemolytic principles in the excretions of the worms when kept *in vitro* appears to favor the view that hemotoxic substances of ascaris partake of the nature of endotoxins. There is also to be considered the possibility that the death of a worm in the intestine may be followed by a rapid disintegration of its tissues and the liberation of toxic substances before it passes out of the body of the host. Tallquist, in fact, has shown that in the case of another parasite (*Dibothriocephalus latus*) that the toxic substances are liberated only when the worm disintegrates, which affords a possible explanation why Dibothriocephalus sometimes produces no ill effects on its host, whereas in other instances a severe anemia is present. The fact that in some cases human beings and other animals infested with ascarids remain in apparent good health while in other cases they show evidences of suffering from such infestation may perhaps be explained in much the same way as the differences observed in cases of infestation with Dibothriocephalus.

Further on Schwartz adds:

The above observations [evidence as to the mechanical attack of *Ascaris* upon the mucosa and the ingestion of blood], coupled with the presence of oxyhemoglobin in the worms, a substance which apparently is constantly being excreted by the parasites (to judge from their behavior *in vitro*)

and which consequently must be as constantly renewed, appear to favor the view that Ascaris probably supplements its food intake by sucking blood from time to time * * *. In this connection it is interesting to observe that coincident with the disappearance of oxyhemoglobin from the worms *in vitro* they become sluggish, and that their existence after the complete elimination of this substance is very brief.

Schwartz's paper should be consulted by those who are interested in the details of the work that has led him to these conclusions.

We feel compelled to end our discussion of *Ascaris* at this point with the comment that another feature presented by the possibility of lung involvement in ascariasis will be the difficulty of diagnosis. Naturally, stool examinations in these early cases will prove nothing one way or another. This presents another problem to the laboratory man. From the foregoing data regarding the physico-chemical phenomena attending *Ascaris* infection it seems to be suggested that the reactions of the blood may prove to be a promising line of attack. It may develop that the differential blood count may show something characteristic during the lung stages of *Ascaris* development. Something may even be done with sero-diagnosis. Already something has been done along the latter line in helminthal infections, notably in precipitin reactions and complement deviation in echinococcus infection and the complement deviation in paragonomiasis. The work of J. G. Thomson(52) on the complement fixation in malaria is another instance of the promise of such work in connection with the animal parasites.

Hookworm.—Only twelve infections with hookworm occurred in this series. The parasite occurred alone in but one case. In four cases it appeared accompanied by *Trichuris,* while *Trichuris* and *Ascaris* were its companions in seven cases. Only one of these infections appeared in a child below 7 years of age. That was case 23, a girl 3 years old. Seven cases occurred in children residing in Manila, or 9 per cent of those living in the city who were in the series; and five cases, or 21.7 per cent, occurred in children from the provinces. That is to say, the incidence of hookworm infection was more than twice as high in provincial as it was in urban children. The probable reasons for this are so obvious as to make it unnecessary to discuss them here.

Both *Necator* and *Ancylostoma* are found in the Philippine Islands. Their incidence and the phenomena accompanying hookworm infection in general have been studied and reported upon by competent observers. There has been found to be not

a little difference in the degree of incidence in various localities. These differences seem to be quite explainable on the basis of local conditions. For instance, in Cagayan Valley, Willets found an incidence of hookworm infection in children under 1 year of 5 per cent, with a steady increase with age until an incidence of 62.22 per cent is recorded by him for children between the ages of 10 and 14 years. This, Willets believes, is due to conditions in the tobacco fields that are peculiarly favorable to the development of the larvæ. We are inclined to suspect that a large proportion of the infections in children under 1 year and in children residing in the city of Manila are orally contracted. "Ground itch" is frequently reported in our out-door dispensary service, but we are reluctant at this time to attribute more than a small proportion of the cases to hookworm invasion. Garcia reports an incidence of 14.28 per cent in his series of Cebu children; Garrison and Llamas report 11 per cent in children. These figures group rather closely around our figure of 12 per cent.

The general impression in the Philippines among physicians and laboratory workers is that the hookworm is not nearly so dangerous a parasite to the Filipinos as it is to other people. We are not yet convinced of the entire truth of that impression; but, at the same time, we do not consider this series justifies us in arguing the point at present. Apparently the incidence of hookworm is greater in adults than it is in children. As an instance of this, one of us,(29) in a recent study of nine cases of dysentery in adult Filipinos, found the ova of *Ancylostoma duodenale* in six of them, which is in harmony with his routine observations.

Many of these infections are exceedingly light and are diagnosed only on centrifugation, while others are so heavy as to yield a diagnosis on direct examination of the fæces. We are quite willing to admit that in a large proportion of cases in children and adults the symptoms are exceedingly mild, but we have seen cases in Filipinos that in every way presented the picture characteristic of severe hookworm infection.

This modification of the symptoms in Filipinos has been explained in two ways. Gomez,(24) who made a clinical study of hookworm infection in the Philippines, doubts that it can be explained on the basis of racial immunity. He inclines to the belief that a prevailing lightness of infection is the determining factor. Other observers adopt the suggestion made by Stiles and others that racial immunity may exist. In this connection

it is interesting to note the behavior of filarial infections in Filipinos. The parasite is very frequently found in some parts of the Southern Islands, but symptoms such as chyluria and elephantiasis are so rare as to attract considerable attention when they occur. Furthermore, in Filipinos as in many other Malayan peoples the larval forms show no diurnal periodicity, but usually may be detected in the blood throughout the twenty-four hours.

Perhaps the answer to these questions could be found were we able to turn back the pages of the Book of Time and discover when the Filipinos or their ultimate ancestors first became infected with nematodes. We are rather inclined to regard these strange phenomena as indicative of a high degree of adaptation between certain nematodes and that congeries of people spoken of as the Filipino people. In that event we should expect that the association of the hookworm, *Filaria,* and their Philippine hosts had dated back to very remote times. If it were possible approximately to fix the date of entrance into the Philippine Islands of the New World hookworm, we might derive some interesting data from a comparative study of the clinical manifestations accompanying infections with *Necator* and *Ancylostoma.*

It seems worth while to mention only one of our cases of hookworm infection, and we leave it to our readers to extract such information from our tables as may interest them.

This was the case of a girl (No. 26), 13 years old, from Batangas Province. Her stool was positive for "Blastocystis," *Spirochæta eurygyrata, Trichomonas,* and hookworm. When her fæces were first examined on August 27, hookworm ova were found in considerable numbers on the first fresh preparation that was made.

The clinical diagnosis was hysteria, ancylostomiasis, and ascariasis. We never discovered any evidence of *Ascaris* infection. The child was stunted as to growth and showed no signs of puberty. Mentally she seemed bright enough, but she was morbid and melancholic at times and when some little attention was shown her she, to use the expression of one of the physicians on the ward, became "very sentimental." After admission it was noted that the child, who complained of pain in the upper abdomen that had persisted for five years, was pale and jaundiced. The total erythrocyte count was 3,280,000, and the hæmoglobin 60 per cent. There were 12 per cent eosinophilic leucocytes. Polymorphonuclear neutrophiles numbered 59 per cent, lymphocytes 28 per cent, and large mononuclears 1 per cent. Roentgen-ray examination gave no evidence of gall-bladder trouble or peptic ulcer, and the fæces were negative for occult blood.

The patient suffered acute pain in the epigastrium of such severity that it was found necessary to administer morphine. Chenopodium treatment was started, but on September 19 the patient was still suffering severe pain notwithstanding that chenopodium had been given twice.

However, repeated concentration of the stools which by this time were dark and very hard in consistence, failed to reveal any more hookworm ova. The hysterical symptoms abated somewhat, but the pain in the abdomen continued to recur periodically, and the patient was eventually taken from the hospital by her relatives against our advice.

We cite this case as illustrating the possibilities of hookworm infection in Filipino children. We feel that it is unwise to be misled into a false sense of security by the stress that has been laid in the past on the apparent modification of hookworm symptoms in the Filipino. Aside from cases of this kind it seems worth while to repeat the statements of two of the earlier workers in the Philippines. Garrison(21) says:

Whether or not the explanation of this apparent rarity of clinical symptoms in hookworm infection among the Filipinos is a racial immunity on the part of the people to the toxins secreted by the worms, * * * the fact that severe clinical manifestations of uncinariasis are rare in the Philippines materially alters the problem which is presented. Instead of producing an acute condition * * * it would appear that in the Philippines hookworm infections play a part more nearly resembling that of the other common intestinal worms to which no definite pathology or severe symptomatology is usually attributed.

Cole,(8) who studied the problem in native scout soldiers, regards the hookworm as a real menace in much the same sense as we regard it. He says:

Everyone suffering from uncinariasis, although it may be mild, is more susceptible to other diseases and having contracted a complicating disease, is more severely attacked because of his weakened condition and also his period of illness is necessarily longer.

In closing our discussion of hookworm infection, and because it has a direct bearing on parasitism in young children, we wish to allude briefly to the statement of Howard,(32) who has reported the finding of hookworm ova in the fæces of a child 14 days old. The mother was infected and showed the usual symptoms of hookworm disease. She gave a history of ground-itch during pregnancy. Howard points out that if infected at the time of birth the infant could not show ova in the stool sooner than the end of the fourth week after its birth. Consequently, he reasons, ova found in the fæces before the end of the fourth week must result from prenatal infection. He reports cases he saw in Ceylon in 1916 in which "the apparent clinical manifestations were out of proportion to the degree of infection and the length of time these children could have had the disease had they acquired it in the usual way and post-natally."

In this connection it may be mentioned that a case of prenatal

infection with bilharzia was recorded in Egypt in 1905.[9] This suggests an interesting line of inquiry in favorable localities such as Cagayan Valley, where the incidence of hookworm infection is high.

Oxyuris vermicularis.—This parasite was encountered once only in our series, through the discovery of one of the ova in a centrifuged specimen of the stool. Garrison and Llamas report it in 1.33 per cent of the children they examined, and Garcia in 0.17 per cent of his series of Cebu children. Other investigators have reported its occurrence in small numbers from various parts of the Philippines. We are of the opinion that it is slightly more common among the American children in Manila and the vicinity. Our case came from Cavite Province.

These figures apparently indicate that *Oxyuris* occurs infrequently in Filipino children. However, the methods of examination used in this series do not favor the detection of *Oxyuris* infections, and other means must be employed if the incidence of this parasite is to be determined. Dr. Luis Guerrero, of Manila, who has had a wide experience in treating parasitism in children assures us that *Oxyuris* is very frequently encountered not only in Filipino children, but in adults as well.

At the beginning of this study there were two points upon which we were especially anxious to secure information. They were included in the cases of dysentery and those suffering from disorders of the nervous system. At the conclusion of our work we find ourselves just as well informed as we were at the beginning and no better.

There is little to be found on study of our cases of ileocolitis that is suggestive of any immediate influence exerted by animal parasites on the course of ileocolitis in children. The only crumb of comfort is afforded by the fact that but one of the six cases that was free from helminthal infection died of the disease. It is left to the surmise of the reader just what influence, as regards the lowering of the vitality of the child before the onset of the disease, was exerted by protozoal and helminthal infections. We prefer not to touch upon it at this time.

The other point was suggested by the paper of Plantier(47) on spasmophilia and intoxication as factors in epilepsy. Plantier has stated that in eliminating the causes for spasmophilia in epilepsy it is wise not to be too hasty in ascribing it to heredity or diagnosing it as essential epilepsy. He states his belief that

[9] Trop. Dis. Bull. 12 (1918) 184.

a continuous abnormal excitation may be transmitted to the motor neurons from foreign bodies, sequestræ, calculi, *helminths*, and so forth. He believes this maintains a kind of tetanization of the hyperactive motor nerve cell of which the partial or complete epileptic seizure is the result. He adds that a superposed toxic action has a tendency to hasten or intensify this.

This looked promising, but unfortunately only one case of epilepsy occurred in the series. That was case 65, female, 10 years old, showing a marked flattening of the skull over the occipital region. Dr. Elias Domingo, of the department of psychiatry of San Lazaro Hospital, to whom the case was referred, gave it as his opinion that in addition to symptoms of marked mental deficiency the child was suffering from essential epilepsy. The child was infected with "Blastocystis," *Spirochæta eurygyrata*, *Trichuris*, *Ascaris*, and hookworm. It was necessary to transfer her to the psychiatric ward at San Lazaro, so we were unable to observe the effects of anthelminthic treatment on her.

Case 60 was admitted for chorea. She was infected with *Ascaris* and *Trichuris*. She seemed less restless after the administration of an effective dose of santonin, but she was discharged before we could observe any marked change in her condition.

DISCUSSION

The great factor with which to reckon here and the one that sets all schemes of sanitation agog is the total lack of appreciation by children, the world over, of the most elementary principles of sanitation and personal hygiene. In this respect the Filipino child is no better and no worse than the child of any other race. With him as with the others if there is an obscure and unlikely means of contracting infection with any given organism, he is exceedingly likely to find it. The fact that 100 per cent of a small group of children have been found to harbor parasites of one kind or another does not in the least constitute an indictment of the modern principles of hygiene and sanitation. It, however, calls for redoubled efforts to clean things up and keep them clean. More than that, it calls for the strengthening of the one weak link in the chain—a closer attention to household hygiene—a task of such formidable proportions in the Tropics and the Far East in general as to seem practically an impossibility.

One can picture the extent of the "clean-up" process that would be required to purge a community of *Trichuris* alone, a

job that would make the hookworm campaign seem like child's play in some respects; for, to begin with, we have no treatment of proved efficacy against *Trichuris*, and the eggs of the organism will remain viable for *five* years. Nematode infections are probably more or less self-limited, and it is likely that in the lapse of time the original race would die out, a given host would be purged of his infection and everything would be serene for the patient. The eggs, however, may have five years to live. Furthermore, our observations over a period of years confirm us in the belief that the supply of worms in the intestine is kept pretty constant, and that reinfection with new and vigorous strains occurs with regrettable frequency. With the helminths we have met in this series, with the exception of *Oxyuris*, auto-infection fortunately does not have to be considered.

With the protozoa the proposition is a little different. The life cycles of the species inhabiting the intestinal tract are not perfectly known except that the question of intermediate hosts and exogenous development seem not to be regulating factors. Forms such as *Coccidium*, *Eimeria*, and *Isospora*, which, of course, did not occur in this series, require at least a number of hours for sporozoite development before they become infective, but their cysts are extraordinarily resistant to unfavorable environmental conditions—much more so than the cysts of the flagellates and intestinal amœbæ. Cysts of the latter are probably infective as soon as they leave the intestine, and it seems probable that in a large proportion of cases they represent rejuvenated strains of the organism, imbued with all the vitality and potentiality for harm which characterized the strains that originally infested the host.

In groups of people confirmed in the habit of feeding themselves with their fingers and whose habits at stool are not above reproach, one is left to speculate as to how many cases are truly chronic and how many represent the working out of a vicious circle that includes the mouth and anus of a single individual.

Dobell and Stevenson(15) have cited cases of *Entamœba histolytica* infection running courses of from sixteen to thirty-four years. But there we have a tissue parasite that in the normal course of events passes very little of its time in the lumen of the intestine and of whose conduct in the tissue we have only imperfect knowledge. Matthews(39) cites a case of *Entamœba coli* infection that seems to have been limited to about one year, but he also cites James' case (in a negro) that ran six years; but there the factor of auto-infection obtrudes itself.

It seems not unlikely that, barring auto- or reinfection, the general run of lumen-dwelling parasites will seek new hosts and leave the original host in the course of a few years at the most. As for the tissue-dwelling parasites, we shall know better when we have means of ascertaining how they maintain their vitality over these long periods of time—just as we are seeking the solution of the same problem with regard to the trypanosomes and the parasite of malaria. With *Entamœba histolytica*, autogamy may occur periodically and solve the problem. In *Balantidium coli* we have a much more highly organized protozoön and one in which there is evidence of conjugation which, when it is fully worked out, may not be dissimilar to the process that has been so fully described in *Paramœcium* by Calkins and Cull. The conditions for conjugation would not seem to be especially favorable in the tissues, but in view of the extreme chronicity of *Balantidium* infections and the high type of the organism, and the fact that evidence of conjugation has never been observed in the tissues, it has long been the opinion of the senior author that endomixis may occur and be the means by which the virulence of the organism is maintained. It is considered good form to regard protozoal infections as being especially virulent in children and young animals. In a general sense this is probably true, but the impressions we have gained, not only in connection with this series, but also from past observations, regarding *Entamœba histolytica* and *Balantidium coli* in connection with children, incline us to the belief that certain things have been overlooked in the past.

These are some of the biological factors involved, but the main factor of practical application would seem to lie in the personal equation—a purely social element. The public schools, visiting nurses, and physicians in Government and private practice will have to shoulder the responsibility in dealing with this very real menace—subtle no less than real. Work along the lines of general sanitation should be pushed with renewed vigor, but the keynote lies in the application of the principles of personal and household sanitation and hygiene that are apt to elude the sanitary inspectors. That means an educational campaign, vigorous and long-sustained. Work of this kind has been undertaken more or less successfully against hookworm and malaria, but it should be stretched to include everything else. It might be remarked that almost every parasite carries its own little individual problem in relation to transmission.

Epigrammatically expressed, we might regard the presence

of protozoan parasites as an expression of an *immediate* filth, where helminth infection possibly presents an index of a more remote and diffuse filth which is all the harder to deal with from the sanitary viewpoint.

Transmission.—Protozoan diseases of the intestine for the most part are cyst-borne. We express ourselves with this reservation for the reason that the problem attending encystation and the transmission of parasites of the trichomonad group is still unsettled in so far as the forms infesting man are concerned. Cysts may be carried by various means—food, water, flies, and, if the whole truth were known, probably by a fairly wide range of arthropod vectors. As a vehicle for the conveyance of protozoal diseases, with the possible exception of the species included in the group of "coccidia," dust is probably a negligible factor, for the cysts of the entamœbæ and probably the general run of intestinal flagellates are poorly adapted to resist desiccation, a fact that has been well established in the case of *Entamœba histolytica*. It is to this that we attribute, in a large degree, the preponderance of helminthal over protozoal infections in this series. The cysts of *E. histolytica* are quickly killed by drying, which may explain in part the low incidence of entamœbiasis in children. But, again, there seems little reason to believe that the cysts of other intestinal protozoa, with the exception of those mentioned, would behave very much differently.

We have regarded *Giardia* as rather a rare parasite in Manila and were somewhat surprised at its incidence in this series. However, we have no basis for forming an opinion as to whether or not there is a tendency to a rise in the incidence. A large proportion of the cases of *Giardia* infection seen by the senior author during the past few years he has been able to trace to Chinese gardeners and, in some cases, to China. Whether rodents are responsible for any of the incidence in the Philippines we cannot say. The senior author has found very few *Giardia* infections in Manila rats.

We have already spoken of the rarity of infections with *Balantidium coli* among children. The problem seems to be somewhat similar to that presented by *Entamœba histolytica*, but certain conditions applicable to *Balantidium* would appear to lend support to our belief that some physiologic factor inherent in children operates to limit infections in them with the obligatory protozoan tissue parasites.

Walker(53) seems to have established pretty definitely the identity of the balantidia of the pig and of man, and among

other important points he has made is that which establishes the domestic pig as the chief source of human infections with *Balantidium* in the Philippine Islands. Furthermore, he has shown that a large proportion of the pigs in and about Manila (and there are many of them) are parasitized with *Balantidium* and are constantly passing the encysted forms of the parasite in their fæces. Encysted forms rarely occur in human fæces. The senior author confesses never to have seen encysted *Balantidium* in human fæces; but Walker was fortunate enough to find them in one or two of his cases, which would appear to be added proof that *Balantidium* is not yet completely adapted to man and that the pig is, perforce, the main source of the infection.

We cannot be absolutely certain that none of our children were infected with *Balantidium;* but, from the thoroughness with which our examinations were made, we think it unlikely that we missed any cases. Latency, however, is a prominent feature of *Balantidium* infections, and the parasites may be absent from the stools over long periods of time during which there will be a total absence of symptoms. Walker says this latency in man is due chiefly to the fact that the patient, although parasitized, is not infected with the parasite, but in part to the chronicity of the ulcerative process in infected cases.

In a measure, the problem of infections with *Balantidium* is tied up with that of *Ascaris;* for, granting that *Ascaris suum* is identical with *Ascaris lumbricoides,* we may assume that the pig may serve as a source of infection with both organisms. That being the case, why do children whose daily life brings them into frequent contact with the ground that has been traversed by pigs, and often in more or less intimate contact with the pigs themselves, contract *Ascaris* infections and escape infections with *Balantidium?*

Of the helminths occurring in our series only one, *Oxyuris* (and that occurred in a solitary instance), is capable of direct transmission or auto-infection. Hookworms have in the past been thought to have a comparatively limited existence in their passage between hosts, but recent observations raise a doubt on this point. *Ascaris* and *Trichuris* ova are known to be long-lived and resistant to unfavorable conditions, and it seems likely that many cases are picked up by the children when they play about the dusty streets and roads. Carriage by flies has been proved, but we doubt if this is an important factor with the children—there are too many other better and more "convenient" opportunities.

Commes(9) has reported some interesting observations from Africa which might apply in the rural districts of the Philippines. He has written of the frequency of helminthal infections of natives and Europeans at Bamako, Upper Senegal. The source of these infections, he believes, may be traced to the drinking water taken from the Niger. He has made periodical examinations of the deposit resulting from the addition of alum to 10 liters of river water and has found microscopically, after centrifugation, the ova of *Trichuris, Ascaris,* and *Ancylostoma.* He has found that the *Trichuris* eggs occur in greatest abundance in the dry season and those of *Ascaris* during the winter months. The ova of *Ancylostoma* show no seasonal variation.

Dogs abound in and about Manila to the extent that they constitute a real nuisance at times, but notwithstanding this they do not appear to figure as important factors in the spread of helminthal diseases. Mendoza-Guazon, in her paper describing the only case of human infection with *Dipylidium caninum* recorded in the Philippines, explains this on the ground that Filipino children of the lower classes are not fond of playing with dogs and cats as are the children of other races, and are usually kept out of the reach of these animals in their infancy. As regards people of the tribes that eat dog meat, she adds that the hair of the dog is singed before the skin is removed.

In his study of the intestinal worms of dogs in the Philippine Islands, Wharton(54) reported these findings in dogs obtained from the public pound in Manila:

	Number.	Per cent infected.
Dogs examined	118	.....
Dogs infected	115	97.45
Hookworms (Ancylostoma caninum)	114	96.61
Toxascaris limbata	8	6.77
Gnathostoma spinigerum	8	6.77
Spiroptera sanguinolenta	7	5.92
Dipylidium caninum	55	46.56
Dibothriocephalus sp	7	5.92
Total infections	199	168.55

At least two of the above are under suspicion as being capable of infesting man. *Dipylidium* has already been reported by Mendoza-Guazon, and Hall(25) has reported a case of human infestation with *Toxascaris limbata* in Michigan, U. S. A.

Both Wharton and Mendoza-Guazon comment on the well-known rarity of cestode infection in the Orient, and Wharton adds that he has never discovered infestation with any tape-

worms of the family Tæniidæ in either a dog or a cat in the Philippines.

Wharton, however, speaks of several cases of larval infections of man with *Echinococcus granulosus*, but has no authentic report of the finding of an adult in the Philippine Islands. He accounts for the absence of tænia forms that are found in dogs by the lack of suitable intermediate hosts—rabbits and sheep.

The question of infant feeding has engaged the attention of medical men since the early days of American occupation, and it is still a difficult problem. In Manila, much good has been accomplished by the free milk depot of the Gota de Leche, but it can provide for only a small proportion of the infant population of the city. The prevalence of rinderpest is responsible in a large degree for the difficulty experienced in getting fresh milk for infant feeding. Musgrave and Richmond(46) quote Carter as pointing out that even when fresh milk is obtained, it is frequently improperly diluted or contaminated by the use of water from an impure source, giving rise to intestinal disorders and malnutrition which are rapidly fatal.

Musgrave and Richmond state that breast feeding is probably attempted in almost every case, but the percentage of exclusively breast-fed children certainly is smaller than in many other countries. This is largely attributable to the lack of sufficient and proper food for the mother. They add (p. 364):

> The conditions which have been outlined and many others, bring about the necessity of instituting artificial food for breast milk in infant feeding to an extent, and at an age of the infant, probably not surpassed if it is equaled in any other country.

This naturally leads to a nondescript diet for a large number of children and the menu soon includes a large variety of home-made preparations—rice sticks, potatoes, bananas and other fruits are given at an early age, and sometimes meat is given to the child before the eruption of the temporary teeth. Boluses of meat have been found in the stomachs of such children at autopsy. The character and percentage of diluents are also heavy contributing factors. Such things, of course, are in themselves bad for the children, but the parasitologist who has seen the manner in which this food is prepared and handled looks upon it mainly as the vehicle for the conveyance of parasites.

Another aspect of the problem is presented by McLaughlin and Andrews(41) in their studies on infant mortality. They say:

* * * In the Philippines the mortality is greatest among breast-fed children, possibly because of the poor quality of the mother's milk * * *. It seems probable that there is an intimate relation between beriberi of infants and a mother's milk poor in quality and lacking certain necessary elements which are not included in the mother's dietary.[10] At first glance it might seem advisable to supplant breast feeding by artificial, but under existing conditions this would be a blunder. The children saved from beriberi would be sacrificed to enteric diseases. That small part of our infant population which is artificially fed furnishes 65 per cent of the deaths from enteric diseases, and the breast-fed, much the larger part of the population, furnishes but 35 per cent of the infant mortality from this cause; so that even in Manila, breast-feeding of infants exerts a deterrent influence upon the mortality from gastrointestinal diseases.

This presents, in a few words, the rather embarrassing dilemma that confronts the Filipino child. It must be said, however, that discoveries made in connection with infantile beriberi since the above was written have helped in a measure to obviate much of the danger from that source.

With a view to remedying the situation presented by the lack of fresh milk, Heiser(30) started experiments on the breeding of a hardy variety of milk goats during his period of duty in the Philippines. The idea was not developed, however.

Without for an instant denying that breast-fed children and those fed on properly prepared artificial food will escape intestinal diseases of bacterial origin in a large proportion of instances, we believe these measures limit infections with the animal parasites to a lesser degree, and this conclusion is not based on the present study alone, but on a much more extended series of general observations extending over a considerable period of time.

SUMMARY

One hundred sick Filipino children have been studied with regard to intestinal parasitism. Of the total number 92 per cent were found to be infested with one or more parasites. Under 1 year the incidence was 66.6 per cent; between the first and second years, 73.6 per cent. All the children between the ages of 2 and 13 years were found to be parasitized.

The earliest case of parasitism was encountered in a child 7 months old.

We have not considered the matter of treatment of these cases in this study.

[10] McLaughlin and Andrews wrote in 1910.

Multiple parasitism has been a complicating factor, and the need is shown for the study of the specific symptoms, if any, produced by the individual parasites. This should be done with strict regard to the race involved, for there is a lack of uniformity of action produced by parasites in the different races.

No protozoön of proved pathogenicity has been encountered in the series. Nearly all the protozoan infections were moderate. The absence of obligatory tissue parasites from this series as well as their rarity in children of the Filipinos is regarded as having some significance. It is suggested that an apparent immunity of children to forms such as *Entamœba histolytica* and *Balantidium* may have a physiological basis in the child.

The incidence of infections with *Spirochæta eurygyrata* was high (61 per cent); and, although no significant phenomena are recorded, it is suggested that further investigation of this parasite is called for.

Our experience coincides with that of numerous other workers who have failed to record any definite train of symptoms that can be attributed to intestinal parasites other than those that are specifically pathogenic. Several patients that were not parasitized at the time they came under our observation presented symptoms that might easily be attributed to parasites. At the same time, concomitant infestation with *Trichuris* and *Ascaris* is accompanied by a train of symptoms referable to the digestive tract that present an almost characteristic picture. In several of these cases the clinician gave a diagnosis of ascariasis that was later confirmed by the finding of the ova of *Ascaris* and *Trichuris* in the fæces.

No data were secured that would aid in determining a possible influence of parasitism on the mental development of any of the children studied, and very little information was collected that was suggestive as to effects on the nervous system. The methods employed with regard to these two factors we do not consider adequate, however.

Study of our cases of ileocolitis, likewise, has failed to yield anything satisfactory concerning the influence of parasitism on the incidence or course of ileocolitis.

Infections with *Trichuris* and *Ascaris* we regard as offering a serious problem in pediatrics. The combination of the two helminths is one that is especially serious in as much as the entire alimentary tract is involved.

Children occasionally purge themselves of *Ascaris* infections,

particularly if they are complicated by *Trichuris* infection. This occurs through vomiting or defecation of the worms, or both.

Helminthal infections were restricted to the Nematoda. No infections with either Cestoda or Trematoda were encountered.

Respiratory diseases other than tuberculosis, influenza, and pleurisy were met in 33 per cent of the children studied, and in this connection attention is drawn to the recent work of Stewart and others on the life history of *Ascaris*, it being suggested that the lung stages of the worm may be responsible for much of the respiratory disease among Filipino children. The difficulty of diagnosing these cases is pointed out.

It is planned to study the fæces of a series of children admitted to the hospital for treatment of respiratory diseases (other than tuberculosis and influenza). Those children who, on admission, are found to harbor *Ascaris* will be rejected from the series. The stools of the others will be followed for several weeks to discover if the ova appear in the fæces following the pulmonary trouble. Such evidence while not absolutely convincing will, nevertheless, be highly suggestive.

Infection with hookworm was found in 12 per cent of the series. Only one severe case is recorded, but it is suggested that the traditional mildness of hookworm disease among the Filipinos should not bring about a false sense of security with regard to it.

A comparative study of the clinical symptoms attending infections with *Necator* and *Ancylostoma* is suggested with a view to discovering if one is more harmful than the other.

It is also suggested that there should be a reëxamination of the evidence regarding eosinophilia in all the helminthiases.

Sanitary conditions are a heavy factor in the infection of children, but the weak link lies in the failure to educate mothers in the principles of domestic hygiene. A given city may be "clean" to educated people but insanitary with respect to the child. Campaigns through the schools, visiting nurses, and physicians should be instituted and maintained.

Parasitism starts coincidentally with bottle or artificial feeding and even breast-fed children do not escape in all cases.

Domestic animals such as dogs and cats apparently are not an important factor in the spread of parasitism among Filipino children, *so far as our present knowledge goes.*

We believe that intestinal parasitism, both directly and indirectly, contributes heavily toward the high death rate in young

Filipino children. While general sanitary conditions are largely responsible for this, still we believe that so far as the children are concerned the problem is one of education of the masses in the simpler principles of domestic hygiene. This will be a formidable task, but it is one on which the Government may with profit expend large sums of money. It calls for the development of the principles of parasitism and preventive medicine on a particularly high plane in the Philippine Islands where parasitic infestations are more common probably than in any other country from which there are records.

Endolimax nana and *Dientamœba fragilis* are reported for the first time from the Philippine Islands. *Eutrichomastix* is provisionally reported.

REFERENCES

(1) ACTON, HUGH W. The significance of Charcot-Leyden crystals as an indication of amœbic colitis. Indian Journ. Med. Res. 6 (1918) 157.

(2) ALBERT, JOSÉ, and ARVISÚ, TEODORO. Physico-mental development of Filipino children. Read at the III Asamblea Reg. Méd. y Farm. de Filipinas, Manila (1916), Feb. 11. (Privately printed.)

(3) ALBERT, JOSÉ, and MENDOZA, MARIA PAZ. Proc. 9th Annual Meeting Philippine Islands Med. Assoc. Cited by Crowell and Hammack, No. 11.

(4) ARAGAO, H. DE B. Copromastix prowazeki n. g., n. sp. (Nota Previa). Brazil Med. 30 (1916) 49.

(5) BRUG, S. L. Endolimax williamsi: The amoeboid form of the iodine cysts. Indian Journ. Med. Res. 6 (1919) 386.

(6) CHALMERS, ALBERT J., and PEKKOLA, WAINO. Chilomastix mesnili (Wenyon, 1910). Ann. Trop. Med. & Parasit. 11 (1918) 213.

(7) CHATTERJEE, C. G. Trichomastix hominis (n. sp.,) parasitic in human intestine. Indian Journ. Med. Res. 5 (1917) 217.

(8) COLE, C. L. Necator americanus in natives of the Philippine Islands. Philip. Journ. Sci. § B 2 (1907) 333.

(9) COMMES, CH. L'eau du Niger et l'helminthiase intestinale. Bull. Soc. path. exot. 10 (1917) 730.

(10) CROPPER, J. W., and ROW, R. W. HAROLD. A method of concentrating Entamœba cysts in stools. Lancet 1 (1917) 179.

(11) CROWELL, B. C., and HAMMACK, R. W. Intestinal parasites encountered in five hundred autopsies, with reports of cases. Philip. Journ. Sci. § B 8 (1913) 157.

(12) CROWELL, B. C., and HAUGHWOUT, F. G. Observations on the incidence of intestinal spirochetes in the Philippine Islands. Journ. Infect. Dis. 22 (1918) 189.

(13) DA MATTA, ALFR. Considerations sur l'entero-trichocephalose et la trichocephalose appendiculaire. Bull. Soc. path. exot. 10 (1917) 932.

(14) DEGORCE, ARMAND. Calculs des conduits biliares developpes autour d'oefs et de debris d'ascaris. Bull. Soc. Med.-Cirurg. Indochine. 10 (1919) 48.

(15) DOBELL, CLIFFORD, and STEVENSON, A. C. A note on the duration of infections with Entamœba histolytica. Trans. Soc. Trop. Med. & Hyg. 11 (1918) 168.

(16) DUNN, C. H. Am. Journ. Dis. Child. 11 (1916) 85. Cited by Mendoza-Guazon, No. 43.

(17) FANTHAM, H. B. Observations on Spirochæta eurygyrata as found in human fæces. Brit. Med. Journ. No. 2893 (1916) 815.

(18) FANTHAM, H. B., and PORTER, ANNIE. The pathogenicity of Giardia (Lamblia) intestinalis to men and to experimental animals. Brit. Med. Journ. No. 2900 (1916) 139.

(19) FLURY. Arch. f. exp. Path. u. Pharm. 67 (1912) 275. Cited by Crowell and Hammack, No. 11.

(20) GARCIA, FAUSTINO. Common intestinal parasites. Philip. Journ. Sci. § B 12 (1917) 25.

(21) GARRISON, P. E. The prevalence and distribution of the animal parasites of man in the Philippine Islands, with a consideration of their possible influence upon the public health. Philip. Journ. Sci. § B 3 (1908) 191.

(22) IDEM. A new intestinal trematode of man. Philip. Journ. Sci. § B 3 (1908) 385.

(23) GARRISON, P. E., and LLAMAS, ROSENDO. The intestinal worms of 385 Filipino women and children in Manila. Philip. Journ. Sci. § B 4 (1909) 185.

(24) GOMEZ, LIBORIO. A clinical study of hookworm infection in the Philippines. Philip. Journ. Sci. § B 6 (1911) 239.

(25) HALL, M. C. Parasites of the dog in Michigan. Journ. Am. Vet. Assoc. 51 (1917) 383.

(26) IDEM. The longevity of adult ascarids outside the body of the host. Studies Res. Lab., Parke, Davis & Co., No. 120 (1917) 51.

(27) HAUGHWOUT, F. G. The tissue-invasive powers of the flagellated and ciliated protozoa with especial reference to Trichomonas intestinalis—A critical review. Philip. Journ. Sci. § B 13 (1918) 217.

(28) HAUGHWOUT, F. G., and DE LEON, WALFRIDO. On the ingestion of erythrocytes by Pentatrichomonas sp., found in a case of dysentery. Philip. Journ. Sci. 14 (1919) 207.

(29) HAUGHWOUT, F. G., LANTIN, P. T., and ASUZANO, M. A. Protozoölogical and clinical studies on the treatment of protozoal dysentery with benzyl benzoate. I. A preliminary report on 8 cases of entamœbic and 1 case of bacillary dysentery treated at the Philippine General Hospital. Arch. Int. Med. 24 (1919) 383.

(30) HEISER, V. G. Unsolved health problems peculiar to the Philippines. Philip. Journ. Sci. § B 5 (1910) 171.

(31) HILARIO, J. S., and WHARTON, L. D. Echinostoma ilocanum (Garrison). A report of five cases and a contribution to the anatomy of the fluke. Philip. Journ. Sci. § B 12 (1917) 203.

(32) HOWARD, H. H. Prenatal hookworm infection. Southern Med. Journ. 10 (1917) 793.

(33) JEPPS, M. W., and DOBELL, CLIFFORD. Dientamœba fragilis, n. g., n. sp., a new intestinal parasite of man. Parasitol. 10 (1918) 352.
(34) KOFOID, C. A., KORNHAUSER, SIDNEY I., and PLACE, J. T. Intestinal parasites in overseas and home service troops of the U. S. Army. Journ. Am. Med. Assoc. 72 (1919) 1721.
(35) KOFOID, C. A., KORNHAUSER, SIDNEY I., and SWEZY, OLIVE. Structure and systematic relationship of the "Iodine Cysts" from human feces. Milit. Surg. 45 (1919) 30.
(36) KOFOID, C. A., and SWEZY, OLIVE. Mitosis and multiple fission in trichomonad flagellates. Proc. Am. Acad. Arts & Sci. 51 (1915) 289.
(37) LUTZ, ADOLPH. Zur Frage der Uebertragung des menschlichen Spulwurms. Weitere Mittheilungen. Centralbl. f. Bakt. 3 (188) 425.
(38) MANTOVANI, M. Intestinal lambliosis. Gazz. degli Osp. e delle Clin., Milan 40 (1919) 66. Cited in Journ. Am. Med. Assoc. 72 (1919) 1259.
(39) MATTHEWS, J. R. The course and duration of an infection with Entamœba coli. Ann. Trop. Med. & Parasit. 13 (1919) 17.
(40) MATTHEWS, J. R., and SMITH, A. MALINS. The spread and incidence of intestinal protozoal infections in the population of great Britain. III. Children. Ann. Trop. Med. & Parasit. 12 (1919) 361.
(41) MCLAUGHLIN, A. J., and ANDREWS, V. L. Studies in infant mortality. Philip. Journ. Sci. § B 5 (1910) 149.
(42) MENDOZA-GUAZON, MARIA PAZ. A case of infestation with Dipylidium caninum. Philip. Journ. Sci. § B 11 (1916) 19.
(43) IDEM. Study of the anatomico-pathological lesions in one thousand Filipino children under five years of age. Philip. Journ. Sci. § B 12 (1917) 51.
(44) MOSLER. Cited by Leuckart, Rudolph. Die menschlichen Parasiten und die von ihnen herrührenden Krankheiten 5 (1867) 2, 1 Lief.
(45) MUSGRAVE, W. E., CLEGG, M. T., and POLK, M. Trichocephaliasis, with a report of four cases, including one fatal case. Bibliography by M. Polk. Philip. Journ. Sci. § B 3 (1908) 545.
(46) MUSGRAVE, W. E., and RICHMOND, G. F. Infant feeding and its influence upon infant mortality in the Philippine Islands. Philip. Journ. Sci. § B 2 (1907) 361.
(47) PLANTIER, L. Spasmophilia and intoxication as factors in epilepsy. Rev. Méd. Paris 35 (1918) 620.
(48) RANSOM, B. H., and FOSTER, W. D. Recent discoveries concerning the life history of Ascaris lumbricoides. Journ. Parasit. 5 (1919) 93.
(49) ROTHE. Deutsche med. Wochenschr. 37 (1911) 343. Cited by Mendoza-Guazon, No. 43.
(50) SCHWARTZ, BENJAMIN. A blood-destroying substance in Ascaris lumbricoides. Journ. Agr. Res. 16 (1919) 253.
(51) STRONG, S. B. Trichocephalus dispar. Southern Med. Journ. 11 (1918) 345.
(52) THOMSON, J. GORDON. Experiments on the complement fixation in malaria with antigens prepared from cultures of malaria parasites. Proc. Roy. Soc. Med. (Sec. of Med.) 12 (1919) 39.
(53) WALKER, E. L. Experimental balantidiasis. Philip. Journ. Sci. § B 8 (1913) 333.

(54) WHARTON, LAWRENCE D. The intestinal worms of dogs in the Philippine Islands. Journ. Parasit. 4 (1917) 80.

(55) WILLETS, DAVID G. A statistical study of intestinal parasites in tobacco haciendas of the Cagayan Valley, Philippine Islands. Philip. Journ. Sci. § B 6 (1911) 77.

(56) YORKE, WARRINGTON. The presence of Entamoeba histolytica and E. coli cysts in people who have not been out of England. Trans. Soc. Trop. Med. & Hyg. 11 (1918) 291.

(57) YORKE, W., and MACFIE, J. W. S. The phagocytosis of erythrocytes by an amoeba of the limax type. Ann. Trop. Med. & Parasit. 13 (1919) 133.

(58) YOSHIDA, SADAO. On the development of Ascaris lumbricoides L. Journ. Parasitol. 5 (1919) 105.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Growth curves for dogs fed on fresh and autoclaved milk. 75

A TRYPANOSOME ASSOCIATED WITH A FATAL DISEASE IN THE CARABAO

By Frank G. Haughwout
Protozoölogist, Bureau of Science, and Professor of Protozoölogy, University of the Philippines

and

Stanton Youngberg
Chief Veterinarian, Bureau of Agriculture

THREE PLATES AND TWO TEXT FIGURES

The following observations were made on some blood films taken from a male carabao (No. 1893) at the rinderpest immunizing station at San Fernando, Pampanga Province, P. I., in July, 1916. We have delayed the publication of this report in the hope that we should come across other animals infected with the same trypanosome, but up to the time of writing this paper no other cases have come to our notice.

The carabao was inoculated simultaneously on May 28, with virulent rinderpest blood and anti-rinderpest serum. The animal showed no reaction from the inoculation, so another injection of virulent blood was made ten days later. It became evident that the blood employed in the original simultaneous inoculation was not virulent, for a very strong reaction followed the second injection.

In due time the animal recovered from the reaction and seemed perfectly normal until the eighth day when its temperature began to rise and its appetite to decline, and a bloody diarrhœa developed. Later symptoms were hæmaturia, hæmorrhages from the skin, and difficult breathing. The discharge from the nostrils became bloody, and gaseous swellings developed on the back and neck. These swellings, when incised, yielded a fluid that was very offensive in odor. The condition of the animal finally became so bad that it was seen that recovery was out of the question. Accordingly it was destroyed on July 3. As reported to us, the autopsy findings showed the entire carcass to be yellow in color. There was severe hæmorrhage of the heart, and the liver was extremely friable. This chain of clinical symptoms is unlike anything we have heretofore noted in the carabao.

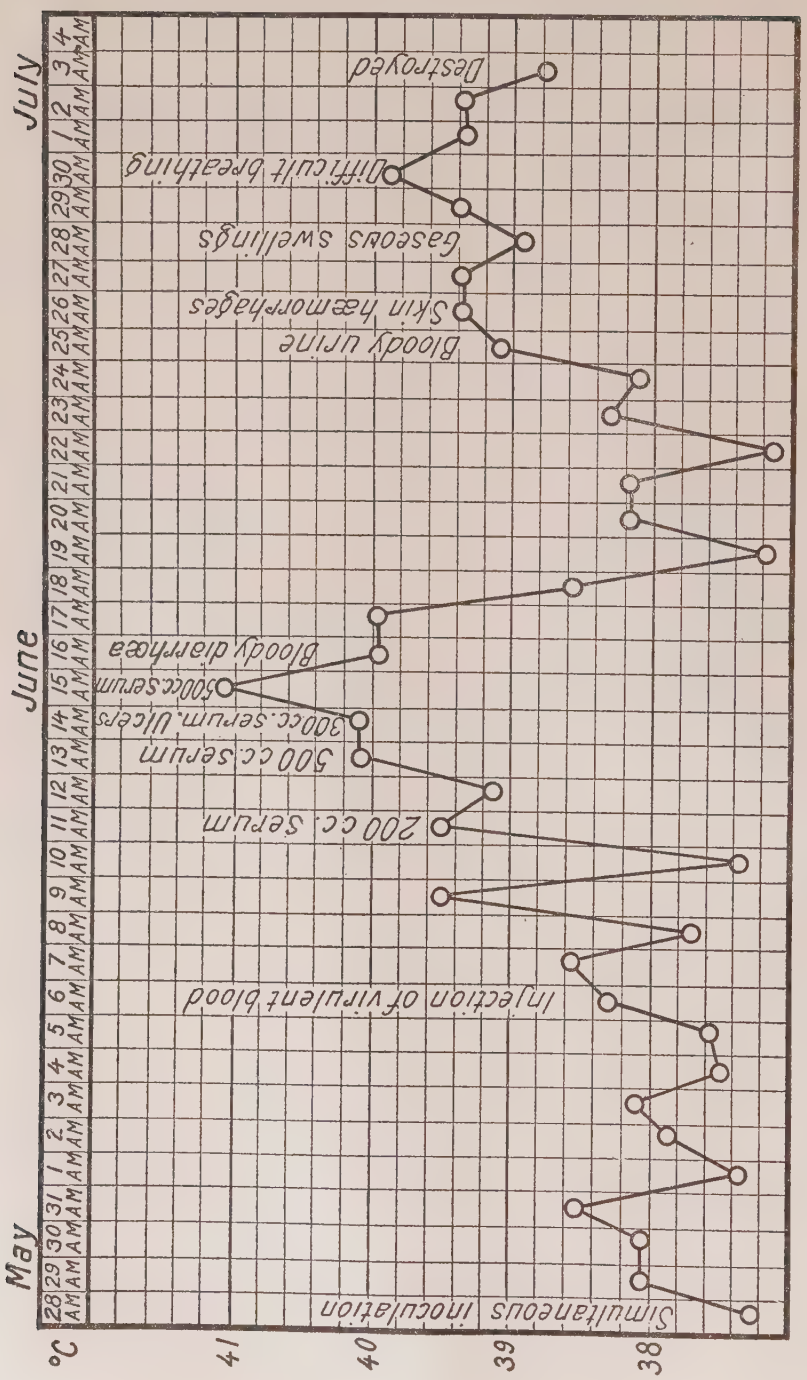

FIG. 1. Temperature curve of carabao 1893.

Several blood smears were made at the time of the autopsy and the slides were later forwarded to Manila where they were stained with Wright's solution and examined. Numerous trypanosomes, much larger and of a different type than *Trypanosoma evansi* were found. In many ways, the trypanosome resembles *Trypanosoma theileri*, but from the preparations at hand we are not prepared to place it definitely in that species.

As might be expected, the material was not particularly suited to a careful cytological study and we were able to find on the slides relatively few trypanosomes that did not show signs of plasmolysis or the untoward effects of delayed fixation and staining characteristic of material collected in the Tropics. Other trypanosomes failed to take the stain properly and attempts to restain them only made a bad matter worse. We were, however, able to find one hundred individuals in a fair state of preservation, some of which are shown in Plates 1 and 2. As will be seen on inspection of fig. 2, the trypanosome is quite polymorphic, its length ranging from 22 μ to 45 μ. These measurements are of the body only, the free flagellum being unstained in all but a few individuals. In those individuals in which the entire free flagellum could be distinguished, it showed a length of from 15 μ to 26 μ. The proportion it bore to the size of the body in individual instances can be seen in Table 1.

TABLE 1.—*Measurements of Trypanosomes, including free flagella.*

Length of body.	Length of free flagellum.	Total length.	Maximum width.
μ	μ	μ	μ
36.0	21.0	57.0	3.0
38.0	19.0	57.0	3.0
34.0	15.0	49.0	2.5
37.5	20.0	57.5	3.0
33.5	21.0	54.5	2.5
37.5	19.0	56.5	2.5
32.0	19.0	51.0	3.0
35.5	18.0	53.5	2.5
33.5	26.0	59.5	2.5
23.5	21.0	44.5	2.5
29.5	20.0	49.5	2.5
32.5	20.0	52.5	3.0
30.5	19.0	49.5	3.0
35.5	19.0	54.5	4.5
22.0	12.0	34.0	2.0
33.5	13.0	46.5	2.0
28.0	14.0	42.0	2.0
30.0	14.0	44.0	2.5
37.0	16.0	53.0	2.5
38.5	15.0	53.5	2.5

The trypanosome is a long, graceful organism, rather pointed anteriorly but usually having a bluntly rounded posterior extremity. The stained preparations show the protoplasm of the main portion of the body to be finely granular with a structure that is more or less alveolar except toward the posterior end, where the cytoplasm is clearer and more hyaline. In those individuals to which we refer, provisionally, as normal forms the round to slightly oval nucleus lies at about the middle of the body. Apparently the nucleus is of the protokaryon type with a rather small karyosome and abundant peripheral chromatin arranged around the internal surface of a nuclear membrane. The parabasal body [1] lies at about the beginning of the posterior fourth of the body. In some individuals we were able to distinguish a finer granule, lying just anterior to the parabasal, which we are inclined to regard as the blepharoplast, for it seems to be associated with the origin of the flagellum. This is shown in Plate 1, figs. 8 and 9. Figs. 10 and 11 on the same plate also show two bodies, apparently in division. We are unable to determine if they represent the early division of a blepharoplast-centrosome, a division of the parabasal, or some wholly fortuitous element. Such interpretations are not to be made with any confidence in material that has undergone the treatment that this did.

In individuals of the more normal type the undulating membrane was seen to be long and thrown into graceful folds. Unfortunately no dividing forms were encountered.

Of especial interest to us, however, was the relation between the nucleus and the parabasal shown in several individuals. In some cases this had brought about the development of what might be termed a pseudo-crithidial form of the parasite. There were instances where the parabasal lay anterior to the nucleus, the flagellum springing from its region and pursuing the usual anterior course as the margin of the undulating membrane and terminating anteriorly as a free lash.

In view of the fact that cultural forms and those that have passed through subinoculation are not involved here, the condition is somewhat novel—at least, it is novel to us in a country where *Trypanosoma evansi* is the only species of importance.

[1] We have adopted the term parabasal as employed by Kofoid and his coworkers in preference to Woodcock's term "Kinetonucleus." For a discussion of the considerations here involved see Swezy, Olive, The kinetonucleus of flagellates and the binuclear theory of Hartmann, Univ. Calif. Pub. in Zoöl. 16 (1916) 185.

Our previous experience with the so-called crithidial forms has been restricted to cultural trypanosomes and to species of *Crithidia* found in arthropod hosts. The picture of *Trypanosoma rhodesiense* as set forth by Stephens and Fantham(8) is already well known to men whose opportunities have made them much more familiar with trypanosomes than we are. It is our impression, however, that in the case of *T. rhodesiense* the posterior nucleated forms are more or less restricted to the short, stumpy trypanosomes that are found in subinoculated animals as rats, guinea pigs, dogs, mice, monkeys, rabbits, and horses, and are not seen in the human host.

Inspection of our figures will show that the posterior-nucleated forms are by no means restricted to the shorter individuals, but are included among the longer trypanosomes often referred to as pre-division forms. Then, too, it must be remembered that our material was drawn direct from the original host. There is, of course, the bare possibility, which must not be overlooked, that our carabao may have become infected with trypanosomes drawn from the blood of the carabao from which the virulent rinderpest blood was obtained.

In connection with their work on *Trypanosoma lewisi*, Minchin and Fantham have shown the production of daughter trypanosomes from a parent rosette. These have a crithidial appearance, the parabasal lying anterior to the nucleus. But their figures show the nucleus lying in about the center of the cell, which is short and stumpy and quite different from the appearance presented by most of the trypanosomes on our slides. Furthermore, we failed to find any evidence whatever of somatella formation.

It may be suggested that we are dealing with the "transvaaliense" type of *Trypanosoma theileri*. This may be true, but we can only say that, while not all the literature on *T. theileri* is available to us, inspection of the figures of *Trypanosoma transvaaliense* in Laveran's paper(4) does not conduce to that belief. The impression given by Laveran's figures is totally different from that given by ours and the relative position of the nucleus and parabasal in *T. transvaaliense* seems to have been brought about by anterior migration of the parabasal.

Macfie in his account of trypanosomes found infecting wild *Glossina tachinoides*(5) figures *Trypanosoma pecaudi* (*T. brucei* of Uganda) from his rat No. 16 (see fig. 10, facing p. 438) with a pair of posteriorly situated nuclei near which is found the parabasal. This is in appearance somewhat similar to our

fig. 13, Plate 2. This might be interpreted as evidence of a type of precocious nuclear division along the lines seen in certain of the hypotrichous ciliates. It is hard, however, to reconcile this view with the absence of evidence of division of the blepharoplast, parabasal, and flagellum which should occur before nuclear division. Some of the British protozoölogists, who are quite familiar with the trypanosomes, hold that this appearance, which they have seen in other forms, has nothing to do with fission.

Other species than those already mentioned have been found to possess posteriorly situated nuclei, among them being *Trypanosoma equiperdum, T. equi,* and *T. pecaudi.*

Hartmann and Nöller(2) in their recent paper on the cytology of *Trypanosoma theileri* figure (Taf. 14, fig. 1) a trypanosome with the parabasal immediately in front of the nucleus which, however, is situated at the middle of the animal. It was a cultural form, and they report no such appearance in fresh blood.

Wrublewski,(10) so far as we have knowledge, comes nearest to the conditions obtaining in our case. In his description of *Trypanosoma wrublewskii* Vladimiroff and Yakimoff, which is found in the blood of the Lithuanian bison, Wrublewski mentions the finding of trypanosomes, the trophonuclei of which lay in the mid-portion of the body which was broadened at that point, the kinetonucleus (parabasal) lying in front of the trophonucleus in each case. As the trypanosomes Wrublewski studied were found in blood taken from the hosts after death, his conditions will be seen to correspond somewhat with ours.

Martini(6) describes a trypanosome recovered from the blood of cattle in the Philippine Islands which may be identical with the organism discovered by us. Unfortunately, however, he fails to give measurements of the parasite and it is, therefore, impossible to form any definite opinion on this point. Forms he figures showing the parabasal lying anterior to the nucleus were found in blood cultures, and he says nothing concerning their discovery in the blood of the host during the life of the latter.

Whatever the interpretation of these forms, we are not inclined to regard them as crithidial forms in the true sense of the word. They appear to develop by posterior migration of the nucleus rather than by anterior migration of the parabasal with accompanying attenuation of the anterior end of the trypanosome, characteristic of the assumption of the crithidial stage by a trypanosome. It would be futile at this time to speculate at

length upon this appearance as representing any definite developmental phase of this particular trypanosome, although it might well be that very thing.

There is an interesting resemblance between these individuals and those figured by Kofoid and McCulloch [2] in plate 15 of their paper on *Trypanosoma triatomae*. Their figures, however, are of forms found in the digestive tract of the hemipteran *Triatoma protracta* and their paper does not deal with the forms found in the blood of the vertebrate host.

It must be borne in mind that certain factors were present in the carabao from which the trypanosomes were obtained that might have altered the morphology of the parasites. It is barely possible that the antirinderpest treatment and the injection of virulent blood might have exerted some influence on the trypanosomes. It must also be recalled that the blood from which our slides were prepared was taken from the animal after death. In view of this, it has seemed to us possible that the appearances we have noted may have been the expression of a more or less abortive effort on the part of the trypanosome to develop a crithidial stage similar to that it might be expected to assume in culture or in its invertebrate host. This might be due to the lowering of the temperature and the initiation in the blood of conditions approaching those found in an artificial culture.

Measurements were made (by the method of Stephens) of one hundred individuals selected at random from the best-preserved and stained trypanosomes we could find on the slides. We have plotted the size distribution of these trypanosomes in fig. 2.

In general, we believe the trypanosome described by us more closely resembles *Trypanosoma theileri* than it does any of the larger trypanosomes we have had under consideration. It approaches the descriptions of Theiler(9) and of Laveran(3, 4) more closely than it does the current descriptions of *Trypanosoma americanum*. Martini's description of his trypanosome gives us no clue whatever. Flies of the genus *Hippobosca*, which are credited with being the vectors of *T. theileri*, are frequently found in the Philippine Islands. Musgrave and Clegg(7) report the infection of Philippine carabaos with *Trypanosoma evansi*, a fact we have many times confirmed, but our parasite certainly

[2] Kofoid, C. A., and McCulloch, Irene, On Trypanosoma triatomae, a new flagellate from a Hemipteran bug from the nests of the wood rat Neotoma fuscipes, Univ. Calif. Pub. in Zoöl. 16 (1916) 113.

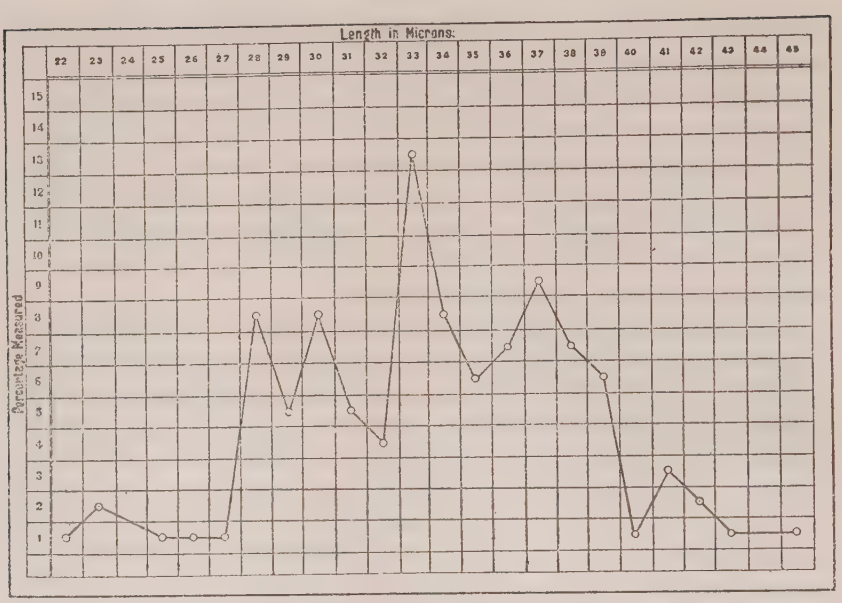

FIG. 2. The distribution according to length of the body, of one hundred specimens of the carabao trypanosome.

is not of that species. Curry(1) has also reported the finding of trypanosomes in Philippine carabaos, but his report, like Martini's, lacks the details that would enable us to make a comparison. *Trypanosoma theileri* has not been reported as occurring in the Philippine Islands.

It is to be regretted that under prevailing conditions we cannot make a systematic search for other cases of this infection. If the trypanosome was actually the cause of the death of our carabao, its presence in the Philippine Islands is likely, sooner or later, to be a serious matter for owners of such animals. If the carabaos, on the other hand, are merely reservoirs for this trypanosome, then we must look for trouble elsewhere. In any event, this particular trypanosome, by reason of its large size and the peculiarities we have described, presents exceptionally attractive material for cytological study which it is to be hoped may be carried out some time in the future. One of the slides which formed the basis of the foregoing description has been deposited in the protozoölogical collection of the Bureau of Science, Manila.

In conclusion, we desire to express our thanks to Dr. W. H. Boynton, of the Bureau of Agriculture, who kindly turned over to us for study the blood preparations of this case.

REFERENCES

(1) Curry, J. J. Report on a parasitic disease in horses, mules and carabao in the Philippine Islands. Amer. Med. 3 (1902) 512. Vet. Journ. 54 (1902) 292.

(2) Hartmann, M., und Nöller, W. Untersuchungen über die Cytologie von Trypanosoma theileri. Arch. f. Protistenk. 38 (1918) 355.

(3) Laveran, A. Sur un nouveau Trypanosome des Bovides. Compt. Rend. Acad. Sci. 134 (1902) 512.

(4) Idem. Au sujet de deux Trypanosomes des Bovides du Transvaal. Ibid. 135 (1902) 717.

(5) Macfie, J. W. Scott. Trypanosomes found infecting wild Glossina tachinoides. Ann. Trop. Med. & Parasitol. 8 (1914) 417.

(6) Martini, Erich. The development of a piroplasma and trypanosoma of cattle in artificial culture media. Philip. Journ. Sci. § B 4 (1909) 147.

(7) Musgrave, W. E., and Clegg, Moses T. Report on trypanosomes and trypanosomiasis with especial reference to Surra in the Philippine Islands. 4th Ann. Rept., Philippine Commission, Bu. Ins. Aff., War Dept., Washington (1903) 419.

(8) Stephens, J. W. W., and Fantham, H. B. Peculiar morphology of a trypanosome from a case of sleeping sickness (T. rhodesiense). Proc. Roy. Soc. (B) 83 (1911) 28.

(9) Theiler, A. A new trypanosome and the disease caused by it. Journ. Comp. Path. & Therap. 16 (1903) 193.

(10) Wrublewski. Cited by Crawley, Howard. Trypanosoma americanum, a common blood parasite of American cattle. Bull. 145, U. S. Dept. Agric., Bur. An. Ind. Washington, 1912.

ILLUSTRATIONS

[Drawings by Haughwout.]

PLATE 1. CAMERA LUCIDA DRAWINGS OF CARABAO TRYPANOSOME

FIGS. 1 to 9. Forms showing normal relations of nucleus and parabasal body.

8 and 9. These show a chromatinic body lying between the parabasal and the proximal end of the flagellum—probably a blepharoplast.

10 and 11. Apparent splitting of the parabasal.

FIG. 12. Elongated individual—probably a predivision form.

PLATE. 2. CAMERA LUCIDA DRAWINGS OF CARABAO TRYPANOSOME; ABERRANT TYPES

FIG. 13. Heterotypical (precocious?) division of the nucleus to form two daughter nuclei. The parabasal body lies beside the posterior nucleus.

FIGS. 14 to 23. Posterior migration of the nucleus to form a pseudo-crithidial type of trypanosome.

24 and 26. The parabasal is overlying the nucleus in each case.

FIG. 25. The parabasal lies anteriorly to the nucleus which has migrated posteriorly.

PLATE. 3. DIAGRAMMATIC REPRODUCTION OF CAMERA LUCIDA SKETCHES OF TWENTY-FIVE SPECIMENS OF THE CARABAO TRYPANOSOME

FIGS. 1, 2, 6, 7, 11, 12, 13, 14, 15, 16, 17, 21, and 22. Show the normal relation between the nucleus and parabasal.

8 and 9. Show an approach to the true crithidial form.

10 and 18. Show an anterior shifting of both the nucleus and the parabasal body.

3, 4, 5, 19, 20, 23, 24, and 25. Show stages in the posterior migration of the nucleus and the assumption of the pseudo-crithidial form.

TEXT FIGURES

FIG. 1. Temperature curve of carabao 1893.

2. The distribution according to length of the body, of one hundred specimens of the carabao trypanosome.

PLATE 1. A TRYPANOSOME OF THE CARABAO.

PLATE 2. A TRYPANOSOME OF THE CARABAO.

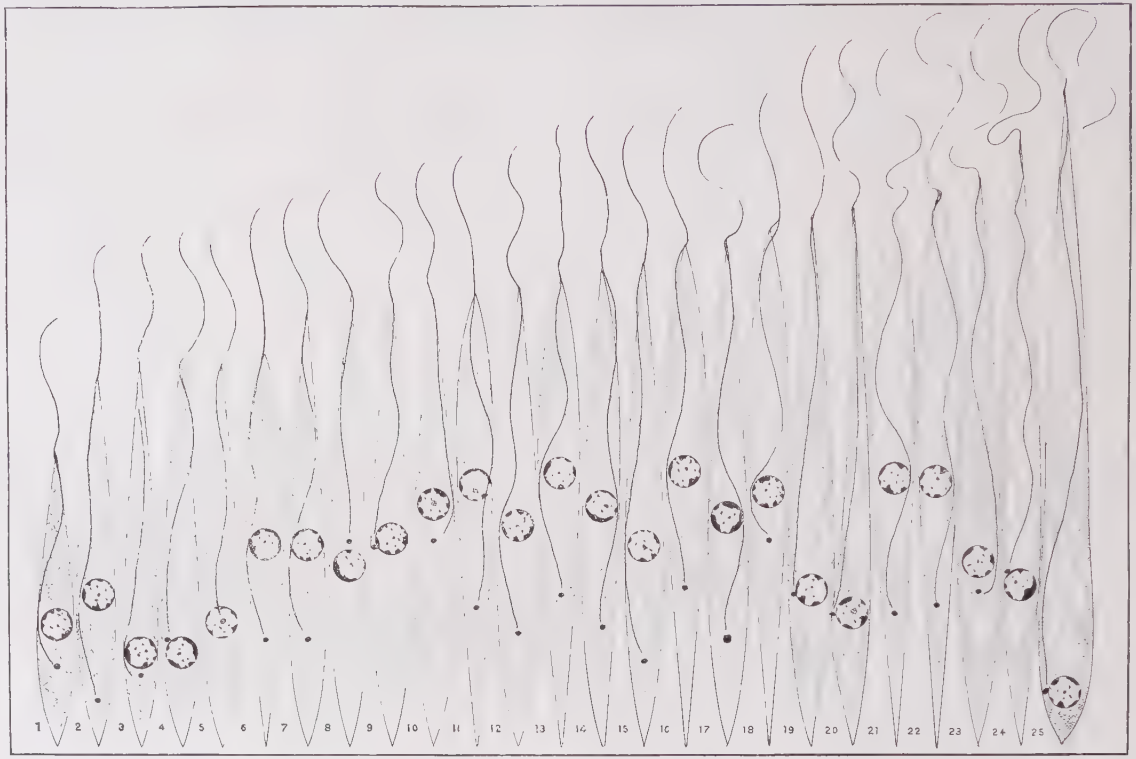

PLATE 3. A TRYPANOSOME OF THE CARABAO.

REMOTE MANIFESTATIONS OF FOCAL DENTAL INFECTIONS, WITH CASE REPORTS [1]

By Ricardo Fernandez

Assistant Professor of Roentgenology, University of the Philippines, and Chief of the Department of Physical Therapy, Philippine General Hospital

It is a common practice in the treatment of certain articular and muscular affections of various types to make clinical and laboratory examinations with a view to determine the presence of so-called chronic rheumatism, acute rheumatic fever, or uric-idæmia or gout; hence the custom of requesting urine examination to enable the practitioner to determine the total amount of uric acid, and also to estimate the quantity contained in the blood. An elaborate medical and dietetic treatment is then given, coupled sometimes with physical therapy, but in the majority of instances such treatment is a failure.

There is no pretension of originality in my paper; the motive that induced me to prepare it was to suggest to my confrères that in such affections they may depart from the line of investigation heretofore followed.

Sinclair Tousey, in the preface of his monograph on "Roentgenographic diagnosis of dental infection in systemic diseases," mentions the observation on the wife of an eminent jurist, who died as a result of an infection localized in the socket of a tooth; this focal infection was diagnosed rather late by means of X-ray. He says:

> The widest publicity should be given to the fact that greatly varying and sometimes serious or fatal systemic diseases and those affecting remote organs are often due to infection connected with the teeth or with the pneumatic sinuses of the face. The infected foci are discoverable by the X-rays. Some of these cases are cured by treatment of the oral lesion and some require also autogenous vaccination with a bacterial culture from the pus in the oral lesion.

Hardly any importance has been given to alveolar abscesses as possible causes of serious and remote disorders in the body; although it has been always considered important to detect the presence of pus in any region of the body, so as to account for,

[1] Read before the Manila Medical Society December 3, 1917.

sometimes, the whole group of symptoms in certain isolated clinical cases. The reason why due consideration has not been given dental infections is that we have been treating morbid conditions; symptoms and their clinical course we never thought might have an intimate relation with dental lesions.

The researches of E. C. Rosenow and of Frank Billings, confirmed later by Hartzell and by others, as to the relation of various pathological manifestations to chronic dental infections, have been the guide of radiologists, dentists, physicians, and laboratory workers. In consequence the medical literature has been enriched by enough data to enable us to form a clear and exact idea concerning the intimate relation existing between chronic dental infections and certain forms of arthritis, neuritis, neuralgia, various types of rheumatic manifestations, and certain pathological conditions in the stomach, the duodenum, the appendix, the gall bladder, the heart, and the kidney, and blood diseases such as pernicious anæmia, etc.

Taking into consideration the fact that the manifestation of chronic dental infection cannot generally be diagnosed with accuracy by any clinical means without the X-rays—and even with them in certain cases with difficulty—I will first deal with the two main dental infections that commonly bear relation to the morbid manifestations mentioned; namely, the apical and periapical abscess and pyorrhœa alveolaris. As a routine in our dental radiograms we employ the extraoral method with photographic plates and, exceptionally, the intraoral by means of photographic films and plates of proper dimensions to be placed within the mouth. We deem the extraoral method more practical, in as much as it enables us to obtain, not only a large number of teeth, but certain information concerning both maxillæ, especially the upper, in its relation with the nasal cavities and the maxillar sinuses.

With a well-conducted technic, we are able to make a complete exploration of both maxillæ, and their respective teeth, by five exposures, whereas twelve at least are necessary in the intraoral method—six exposures for the inferior—provided that every one of the exposures is satisfactory.

In order to save time on one hand, and to avoid the patient being unduly exposed to the X-ray on the other, we decided to use the extraoral in preference to the intraoral.

We use the oblique projection technic recommended by Drs. E. Speder, J. Belet, and J. D. McCoy.

With this technic we succeeded in exploring all the teeth and the maxillæ, and thus could detect any change from the normal appearance of each particular tooth.

In the interpretation of the X-ray plates, for the detection of apical abscess, one must bear in mind the relation of the natural cavities as, for instance, the antrum of Highmore with the superior molars; the nasal cavity with the superior incisors; and the foramen of the inferior maxilla with the inferior premolars. Otherwise, any one of these natural cavities might be wrongly taken as a shadow produced by an abscess, and thus we might give an erroneous diagnosis, with serious consequences. With the foregoing precaution, it is relatively easy to diagnose with accuracy any abscess that might develop in the dental apex or around it, even though there are no clinical symptoms, if the negative shows a dark area circumscribed in the dental apex or in the alveolar cavity, and if this dark area is well defined and sharply separated from the neighboring tissues by a line of demarcation.

This dark area, a very characteristic radiogram of an abscess, is produced by diminution of density, or decalcification and sometimes destruction of the dental tissue. If the dark area is very pronounced, almost black, we can infer the probable presence of pus in the alveolar cavity. It has been proved that the pus may become fluorescent under the influence of the X-rays, and this fluorescence acts as an intensifier of the radiations acting upon the point or site where the abscess is located, and as a result we observe the very pronounced dark zone in the negative.

Pyorrhœa alveolaris, or Rigg's disease, is clinically demonstrable; it is nevertheless wise to remember that the presence of pus around the external border of the gums is not always due to Rigg's disease. A careful examination will sometimes disclose the cause as being the presence of calcareous deposit around the teeth, which may act as an irritant upon the gums and give rise to suppuration.

Clinical examination, aided by the X-ray, makes diagnosis certain in cases of dental infection, and at the same time the extent of the lesion may be determined in this way.

T. L. Gilmer and A. M. Moody are not in accord with Dr. C. J. Grieves, of Baltimore, and Dr. W. S. Baer, of Johns Hopkins University, that *Staphylococcus albus* or *S. aureus* may be the causative agent of apical and periapical abscesses. Through

experiment Gilmer and Moody have been able to identify the preponderance of streptococci in ærobic and anærobic cultures, aseptically obtained from pus in the foci, or the seat of acute, chronic, or latent infections in the maxillæ and teeth. *Streptococcus hemoliticus* was found in acute abscess; *S. viridans,* in chronic; and *S. mucosus* was obtained only once.

Occasionally *Staphylococcus albus* and *S. aureus* have been isolated by some observers in the ærobic cultures, and also *Micrococcus catarrhalis* and some other unidentified saprophytic microörganisms. The streptococci in the anærobic cultures are rarely obtained pure. Some cultures showed the presence in large numbers of *Bacillus fusiformis,* while in a few test tubes there were found pure cultures of this bacillus. C. C. Bass and F. M. Johns give as a specific cause of alveolodental abscess the *Entamœba buccalis* and possibly other species that infect and destroy the peridental membrane.

While Hartzell and Henrici do not claim in their experiments that the streptococcus is an etiological factor in dental abscesses and in *Pyorrhœa alveolaris,* nevertheless from the standpoint of metastatic abscesses they think it is of paramount importance that such microörganisms are constantly present in lesions with ulcerated surfaces; and they probably do invade deeper tissues and gain entrance into the circulatory channels.

Henry L. Ulrich says that out of one hundred seven cases of dental abscesses with bacteriological examination in the Minnesota Hospital, one hundred showed the presence of *Streptococcus viridans;* and out of fifty-two of his private cases, fifty also showed the presence of the same microörganism. There were also found with the above microörganism, *Staphylococcus albus, S. aureus,* and *Micrococcus catarrhalis.*

Hartzell, Henrici, and Leonard, in their posterior researches, made the assertion that they found streptococci in periapical abscesses and in pyorrhœa, and that these streptococci give rise in animals to inflammatory lesions in the cardiac muscle, vegetative growth in the valves, articular infection, inflammation of the blood vessels, and focal and diffuse infection of the kidneys. Similar lesions were observed in human beings upon autopsy, and these investigators believe that the lesions mentioned were caused by streptococci.

Recent bacteriological investigations carried out in the department of medicine of the University of Minnesota disclosed the constant occurrence of *Streptococcus viridans* in chronic dental abscess and pyorrhœa; and, although *Entamœba buccalis*

was also found in oral infections, this is not recognized as the cause of pyorrhœa, as Bass and Johns claim.

It is a scientifically proved fact that the gastric juice is not a barrier against the passage of bacteria and pus into the stomach and the intestines. Microörganisms in the mouth may be swallowed, as actually happens, and they reach the stomach without all of them being destroyed, and thus gain entrance into the intestines, causing under certain conditions throughout their course local affections such as gastric ulcer, appendicitis, etc.

Another route of dissemination from mouth infection is by way of either the lymphatic or the circulatory channels; hence the presence of focal infections of remote origin, as Hartzell, Henrici, and Leonard have shown in their clinical investigations already referred to.

There are localized infections of the tonsils, and others, that may coexist with pyorrhœa and dental abscess; treatment for their eradication does not cure the disease if not properly attended to.

A thorough treatment of the teeth by the dentist, with extraction if necessary, was enough to eradicate all symptoms and other disturbances observed in patients. In instances where a conjoined local treatment by the dentist and the use of vaccines by the physician were available, improvement was rapid, especially when autovaccines were employed.

L. S. Medalla thinks that there is room for vaccine therapy in all cases of acute and subacute dental abscesses; and that, by the employment of this method, a good deal of suffering among patients and the loss of their teeth have been avoided.

In the use of autovaccine the necessary precautions must be taken to obtain the purulent material aseptically, without contamination. An autovaccine prepared under such conditions almost invariably brings about a surprising and rapid disappearance of the symptoms, which may not be observed if one is careless in the preparation of the vaccine.

Hartzell and Henrici believe that the elimination of the focal oral infection is very much more important than the use of vaccine, and they consider this as a mere adjuvant treatment in some cases.

The limited number of cases observed by me corroborate the facts which I have quoted here, in regard to the treatment.

Case 1.—W. T., adult, American, married, male, suffering for some time from lumbosacral and articular pain, the char-

acter and intensity of the former simulating nephritic colic. He looked very pale. Radiograms taken in the lumbosacral region showed the characteristic evidences of beginning *Arthritis deformans*. Radiogram of the teeth showed the evidence of pyorrhœa in the only remaining molar in the lower mandible, right side, and abscess in the second upper bicuspid, left. Under appropiate treatment of the affected teeth, and hygienic care of the mouth, he improved markedly, and the painful symptoms disappeared. Recovery was slow, and there was left some rigidity in the knees on account of the definite lesions observed in the articulations.

Case 2.—F. L., adult, Filipino, male, married, complaining for many months of polyarticular rheumatism with acute exacerbations which prevented him from attending to his ordinary work. The medical and the dietetic treatments as well as the hydrotherapy given him afforded very little relief. Apparently his teeth were in excellent condition, but a radiogram showed the presence of an abscess in the remaining molar in the inferior maxilla, right side. Treatment of the dental abscess without any other medicine caused the gradual disappearance of his symptoms, and in four months he was completely cured.

Case 3.—C. de C., female, Filipino, married; she gave a history of some rheumatic pain; for two months she had been complaining of intense pain in the lumbosacral region, radiating to the left thigh. She was bedridden, and could neither sit nor walk. All previous treatment usually given in such cases was a failure, and the intense pain could be abated only by morphine injection. Radiograms of both kidneys and ureters were negative for stone; the vertebral column and the whole pelvis were entirely normal. Radiogram of both maxillæ showed the presence of abscess in both first molars in the superior mandible. Both molars were extracted under anæsthesia, and cultures of *Micrococcus viridans* and *Staphylococcus albus* were obtained. Autovaccine was prepared and all other treatment previously given was suspended. The first injection given was 33,000,000; on the third day she was given another of 50,000,000. On the day following the first injection there were observed dizziness, nausea, and pain in the teeth, worse on mastication and on drinking cold water. On the sixth day after the first injection she was given another of 50,000,000, and thereafter 100,000,000, at two-day intervals. After the third injection there was abatement of the symptoms observed after the second one and, to her surprise, she was able to sleep and to move her lower

extremities freely. After the sixth injection the patient was able to sit up in bed without any trouble; after the eighth, she could walk alone. Her general condition improved, and she was finally cured very rapidly.

Case 4.—M. de F., adult, female, Filipino; with previous history of some rheumatic affection, and complaining of intense pain in the left shoulder. The radiogram of the shoulder showed evidence of *Arthritis deformans*. She received medical, dietetic, and electric treatment with no improvement. I suggested that an X-ray picture be taken of her teeth, and the radiogram showed an abscess in the first bicuspid, right inferior maxilla, and abscess also in both bicuspids, superior maxilla, with pyorrhœa in the lower incisors. Culture taken from the pyorrhœa was positive for *Micrococcus viridans*. Autovaccine was prepared, and injections of it ameliorated her symptoms, and complete improvement is expected when her teeth will be entirely cured as she is at present under the care of a good dentist.

Case 5.—P. J. C., adult, European; suffering from articular manifestations for twenty years. He was always under dietetic and medicinal treatment, without showing real improvement. Radiogram of both maxillæ positive for pyorrhœa in the last molar, left lower maxilla, and abscess in the last two molars, left inferior maxilla, with pyorrhœa in the second false molar and the first molar, superior maxilla, left side. The two inferior molars were extracted and the culture taken was positive for *Micrococcus viridans*. Vaccine was prepared and after the second injection the patient was able to wear his shoes, and he experienced no trouble on walking.

Case 6.—V. de C., adult, Filipino, female; with previous history of rheumatism following an attack of paratyphoid fever. Ever since she has been having fever with temperature between 38° and 39° and occasionally as high as 40°. All the intestinal symptoms of paratyphoid have disappeared, but there is persistence of some articular pain. There is no indication of any tuberculous lesion. Radiogram of the teeth shows evidence of pyorrhœa in the false molar and the molar supporting a bridge in the inferior mandible, right side; pyorrhœa in all the false molars left side, upper mandible, and also in the two false molars and the first molar, right side, upper mandible. Extraction of the false molars and the true molars, which were quite movable in their sockets, was followed by the disappearance of fever, though later the fever recurred, but in a very slight degree. Culture was positive for *Micrococcus viridans*. Auto-

vaccine was prepared and injections were given, with gradual and complete disappearance of fever.

Case 7.—M. V., adult, Filipino; suffering trifacial neuralgia, right side, for some time. All medical and electric treatment given in Europe was of no avail. There was improvement but never a cure. Radiograms taken show evidences of pyorrhœa in the false molar and canine, right side, inferior maxilla. These teeth were extracted, and the culture taken was positive for *Micrococcus viridans.* As a result of injection of the autovaccine the intervals between attacks of the neuralgia are longer and the pains less intense. Patient is at present under treatment and observation.

Case 8.—M., adult, Filipino, male, married; with previous history of rheumatic pain and venereal disease, very suspiciously like syphilis. He has been suffering for a long time from periodical attacks of trifacial neuralgia, severe in character. He received the usual treatment for trifacial neuralgia, and mercury injections for suspected syphilis. Treatment was a failure. On examination, his teeth were found to be in very poor condition. Radiogram shows evidences of pyorrhœa in the upper bicuspids, right side, and an abscess of the first molar, lower right. Once the pyorrhœa and the abscess were treated, he made a complete recovery.

Case 9.—V., adult, Filipino, married; with previous history of rheumatic pains with acute exacerbations, only relieved by salicylate treatment, but the symptoms never disappeared entirely. Radiogram showed the presence of an abscess in the false molar, and pyorrhœa in some of the teeth. Local treatment of the pyorrhœa and the abscess, and autogenous vaccine, resulted in a complete cure.

Case 10.—J. L., adult, Filipino, married; complaining of acute inflammation of the joint of the right shoulder. Mouth in a very bad condition, with evidences of pyorrhœa. Former treatment for arthritis of no avail. He could not use or move his right arm on account of pains. Polyvalent vaccine was prepared, and after three successive injections of 100,000,000 each, there was observed marked diminution of the inflammation. Ten days after treatment the patient was able to use his right arm.

The cases above reported, and those under my observation and treatment, are certainly very few from which to draw conclusions; but examination of the history of the cases reported will show that the results obtained from the therapeutics fol-

lowed by me fully accord with the outline of treatment discussed. Therefore, as the symptoms disappeared with the disappearance of the focus of infection, the symptomatic manifestations observed were related to the dental infections discovered.

In cases where cultures were made, *Streptococcus viridans* associated with *Staphylococcus* was obtained in one case (3); and in the others, only *Streptococcus viridans* was found. Vaccine of 100,000,000 per cubic centimeter was prepared from the microörganisms obtained from each patient.

Patients treated by the cure of affected teeth or by simple extraction showed gradual recovery, while those who received local treatment, associated with vaccine therapy, recovered more rapidly.

In cases 9 and 10, the use of vaccine therapy, with polyvalent vaccine, gave positive results when associated with local treatment of the infection.

I wish to express my appreciation to Prof. A. G. Sison for his courtesy in making the English translation of this work and for furnishing bibliographical references; to Prof. Jose S. Hilario for the preparation of vaccines; and to Dr. A. de Asis for his valuable coöperation as a dentist.

BIBLIOGRAPHY

1. Bass, C. C., and Johns, F. M. Pyorrhea dentalis and alveolaris. Specific cause and treatment. Journ. Am. Med. Assoc. No. 7 64 (1915).
2. Belot, J. La dent de sagesse et sa radiographie. Journ. Am. Med. Assoc. No. 7 64 (1915).
3. Idem. La radiographie des maxilaires et des dents. Journ. de Radiologie et D'Electrologie No. 1 (1914).
4. Billings, Frank. Mouth infection as a source of systemic disease. Journ. Am. Med. Assoc. No. 23 63 (1914).
5. Idem. Focal infection. The Lane Medical Lectures. D. Appleton and Co., New York and London (1917).
6. Craig, C. Burns. Peridental infection as a causative factor in nervous diseases. Journ. Am. Med. Assoc. No. 23 63 (1914).
7. Darling, Byron C. Oral sepses as a focus of infection, its bacteriological, dental and roentgenological aspects. Am. Journ. Roentg. 3 (1916).
8. Eisen, E. J., and Ivi, H. Robert. Roentgenologic examination in elimination of the mouth as source of infection in systemic disease. Am. Journ. Roentg. No. 5 3 (1916).
9. Gilmer, Thomas L., and Moody, A. M. A study of the bacteriology of alveolar abscess and infected root canals. Journ. Am. Med. Assoc. No. 23 63 (1914).

10. HARTZELL, B. THOMAS, and HENRICI, ARTHUR T. A study of streptococci from pyorrhea alveolaris and from apical abscess. Journ. Am. Med. Assoc. No. 13 64 (1915).
11. MACKEE, GEORGE M., and REMER, JOHN. The apical shadow. Am. Journ. Roentg. No. 3 3 (1916).
12. MCCOY, JAMES DAVID. Dental and oral Radiography. St. Louis (1916).
13. MEDALLA, L. S. Bacterial vaccines in acute septic conditions of mouth. Journ. Am. Med. Assoc. No. 24 61 (1913). Abstracted.
14. MERRIT, ARTHUR H. The Roentgen ray in dental practice. Am. Journ. Roentg. No. 5 3 (1916).
15. OTTOLENGUI, R. Interpretation of dental roentgenograms. Am. Journ. Roentg. No. 3 3 (1916).
16. RHEIN, M. L. Mouth infections. Their etiology and a consideration of what effect they may have on the vital organs and their tissues. Journ. Am. Med. Assoc. No. 7 60 (1913).
17. ROSENOW, E. C. Transmutation within the streptoccus-pneumococcus group. Journ. Inf. Dis. No. 1 14 (1914).
18. IDEM. The production of ulcer of the stomach by injection of streptococci. Journ. Am. Med. Assoc. No. 22 61 (1913).
19. IDEM. Mouth infection as a source of systemic disease. Journ. Am. Med. Assoc. No. 23 63 (1914).
20. IDEM. Etiology of arthritis deformans. Preliminary Note. Journ. Am. Med. Assoc. No. 15 62 (1914).
21. SATTERLEE, FRANCIS LE ROY. Dental Radiology. New York (1913).
22. SPEDER, E. La radiographie dentaire et ses diverses techniques. Arc. D'Elec. Med. Exp. et Clin. No. 348 (1912).
23. TOUSEY, SINCLAIR. Roentgenographic diagnosis of dental infection in systemic diseases. New York (1916).
24. ULRICH, HENRY L. The blind dental abscess. Journ. Am. Med. Assoc. No. 5 65 (1915).

A CASE OF HUMAN SYNOPHTHALMIA[1]

By Sixto de los Angeles
Professor and Chief of Department
and
Anastacia Villegas
Assistant

TWO PLATES

The specimen was donated to the College of Medicine and Surgery through the department of legal medicine on May 29, 1919, by the pharmacist Mr. Gallardo, and the district health officer Dr. J. Guidote of Tacloban, Leyte. The fœtus was born dead on May 26, 1919, in the municipality of Tacloban, Barrio of San Jose. According to the report of Doctor Guidote, it was the sixth child of a normal woman, 25 years of age, married to a man 35 years old, a farmer by occupation and likewise of normal and healthy constitution. The five previous children were also normal.

The case is a male synophthalmia bilentica, measuring 350 millimeters in length, and 233 millimeters in chest circumference. The total leg length is 180 millimeters; the foot, 60; the arm, 130; and the hand, 50. The total cephalic circumference is 210 millimeters (anterior 130, and posterior 180); height of forehead, 5.3 millimeters; facial length, 50; facial width, 57.5; and from the inferior palpebral margin to a place over the mental point it measures 22.8. The pinna measures 25 millimeters. The weight was not taken because when the specimen was received in the department it was without viscera.

Eyelids are not adherent but rather widely gaping; membranæ pupilares absent; nails perfectly developed but not reaching to the tips of the fingers; head well covered with hair; testicles partly descended into the scrotum; body perfectly formed but underdeveloped, and covered with abundant lanugo. The size of the creature corresponds to a seven-month intra-uterine

[1] From the department of legal medicine, medical economics, and ethics, College of Medicine and Surgery, University of the Philippines. Read before the Manila Medical Society, October 6, 1919.

fœtus, but everything else in our findings points to an almost full-term fœtus, probably of eight months.

The anomalies of the monster are confined to the head and neck region. The cranium is microcephalic without apparent sagittal suture on palpation; the face has the shape of the breast of a nursing woman. There is only one orbital cavity, apparently fused, but with the median walls totally absent. It measures 25.6 millimeters in transverse diameter, and 20.5 in height; it is situated in the center of the forehead and contains two fused protruding eyeballs. The palpebræ are widely gaping and everted, presenting both superior and inferior ectropion. There are no puncta lachrymalia.

The nose is also absent. The mouth is represented by a small triangular opening about 1.5 millimeters in diameter, and communicates with what may be termed the buccal cavity. Immediately above this opening is a snoutlike structure, grayish black in color, and rigid to the touch.

The external ears or pinnæ are situated almost horizontally at the anterior part of the neck with the square lobules directed medially and slightly downward. The crura, antihelix, and the tragus of both ears are absent. The conchæ are almost flat.

X-ray pictures of the head have been taken, and the absence of the medial walls of the fused orbital cavity, as well as of the nasal bones, is confirmed. The edges of the parietal bones are so closely approximated that the skull becomes scaphoidal. The lower jaw is rudimentary.

So far as we are able to ascertain, our present case has no duplicate in literature with respect to the following peculiarities: The apparent absence of the external nares (there being no proboscis to substitute them); the peculiar shape, size, and position of the mouth; the location of the ears; and the shape of the face.

Medico-legal aspect.—It is a well-known fact that monstrous births not infrequently become the subject of court investigation, particularly in connection with infanticide and the definition of civil rights of newborn babies. As to the first point, a large proportion, if born alive, is killed on account of the hideous or repugnant features, in spite of the legal rule prohibiting the destruction of monsters.

The present case may be included in the class whose existence is undesirable to parents, so the hideous looks of this creature may be invoked as one of the real motives for the commission of infanticide. On the other hand, in the absence of marks of violence which may indicate criminal intention, the suspicion

of infanticide, if it were to be applied to the present case, is properly eliminated by the fact that there is lack of development of the organs necessary to maintain life, and by the undersize of the fœtus, which presumes weakness.

On the second point, inquiry may arise as to whether such a monster as this possesses the human shape entitled to civil personality as provided by Article 30 of our Civil Code, which says that "in order to be vested with civil rights a child must have human shape and survive twenty-four hours after birth." The importance of this determination rests upon the fact that, although the newborn infant is medically classified as a monster, yet if it is legally pronounced from the medical evidence to have human shape, and if it is born alive and lives at least twenty-four hours after birth, it may inherit or transmit an estate to its heirs-at-law, as if it were a normally formed child. Assuming that the present case was born alive and lived twenty-four hours, the question therefore may be formulated as to whether it has human shape and is entitled to civil rights. As no case of this kind has as yet been brought before the jurist in the Philippines, we cannot here quote court opinions on this matter; but in other countries conflicting decisions have been given regarding monstrosities, because of the lack of a precise legal definition as to what is meant by "human shape."

According to the meaning of English law, malpositions, transpositions, or defects of the internal organs or any of the cavities do not constitute monstrous births; so that the legal question relates only to external shape, not to internal conformation. However, a mere deformity in any part of the body, such as supernumerary fingers or toes, or twisted or deformed limbs, does not constitute a monster in law. On the other hand, a blighted fœtus or a mole is not legally a child, so far as the succession to property is concerned. It appears from Lord Coke's description of a monster—"which hath not the shape of mankind"—that the law must necessarily be guided in its decision by the description of the monstrous birth given by a medical witness. Hence, each case must be decided by the peculiarities attending it.

In French jurisprudence the circumstance seems to be different; if the monstrosity be such as to cause its death soon after birth, or if it lack capacity to maintain independent life, the child is to be pronounced not viable and therefore not capable of acquiring civil rights.[2]

[2] Taylor's Manual of Medical Jurisprudence, 12th Am. ed. 623 and 624.

Etiology.—Concerning the etiology of monstrosities many theories have been advanced, the oldest being that of maternal impression, which is still regarded by the laity as the true cause of monsters. In the case under discussion the mother in explaining the causation of the malformation believes, as she stated to Doctor Guidote, that she could only attribute such defects to maternal impression; for she remembered that during the early part of her pregnancy she had experienced a peculiar feeling of curiosity in observing a deformed doll made of clothes.

Curiously enough this old-time superstition of maternal impression, which has been so universally adhered to through the centuries, had gained supporters, even among scientists, up to the end of the nineteenth century. Fordyce Barker [3] was one of those who were credited with demonstrating the correctness of the theory of maternal impressions. In a paper, read in 1886 before the American Gynecologists, he established the doctrine that—

> When in the early weeks structural development is proceeding at no tardy rate an interference to nutrition in the mother cannot but impress the fetus detrimentally, and the organ interfered with would be that one in the condition of the most active development, or that which could less easily bear arrest, however transient, with impunity. Then too, although no nervous connection has been demonstrated to exist between the mother and the fetus, yet the latter possesses nerves; and alteration of the nutrient power of the mother cannot but act on the nerves that are governing, though it may be only to a slight extent, the growth of the fetus itself.

Against this theory several arguments have been raised; among others that, though intense emotions and apprehensions are experienced by gestating mothers, yet abnormal births are extremely rare. The impressions may come when the anlage or anlagen of structures claimed to be affected have already been formed.

Norman Bridge [4] in a paper written a few decades ago, strongly refuting the theory of maternal impression, says among other things: "To endow the blood with such a weird intelligence as this would require, is too great a load for our credulity."

Probably this popular belief of cause and effect of marks and defects is largely due to accidental coincidence; although an exceptionally profound emotion, because of the complexity of the human organism, might in some yet unknown way influence the growth and development of the fetus.

[3] American Text-Book of Obstetrics (1907) 306.
[4] Op. cit. 307.

Mall has advocated the theory of insufficient nutrition. He maintains that monstrosity may be due to the imperfect development of some ova on account of inadequate nutrition, owing to faulty implantation in a diseased uterus. This theory is applicable only to pathological embryos aborted during the first two months of pregnancy, for it is inconceivable that an ovum suffering from lack of nutrition can reach the full or nearly full term.

Stockard, after performing a series of experiments on the effects of magnesium salts and alcohol on the ova of certain fish, suggested the hypothesis that cyclopia in man may possibly be due to an excess of magnesium salts in the blood of the mother, or to alcoholism of either or both of the parents. This theory is objected to on the ground that it is true to a negligible percentage only, for many alcoholics bring forth normal offspring without any mark or defect; as regards the excess of magnesium salts in the blood, excess of other chemicals brings about similar results. What part this alcoholic theory has played in our present case we cannot tell for lack of information regarding the habits of the parents and the history of the family.

As to the question of pathogenesis of this particular kind of monstrosity, Stockard attributes the downward displacement of the mouth to the circumstance that the cyclopean eye, being frontally located, has caused the mouth to move downward. The interpretation seems insufficient, in view of the fact that Werber in his experiments has observed this condition to occur, not only in cyclopean monsters, but also in some cases of asymmetric monophthalmia and synophthalmia such as we have in the present case.

Investigators on this subject claim that abnormalities of the olfactory pits are almost invariably found to occur in embryos exhibiting various degrees of median cyclopia as well as asymmetric monophthalmia, and that they usually correspond to the anomalies of the eyes of a given embryo; that is, they are either blended into one median pit or they exhibit various degrees of approximation or fusion in the cyclopean embryos.

Stockard in explaining the cause of cyclopia has advanced the hypothesis that there is only one optic anlage, which normally divides into two, but that by the influence of certain chemicals the division fails and a single eye results. This is refuted on the ground that it lacks sufficient proof to back it up.

Some authors allege that the production of a single eye is due

to the fusion of the two optic anlagen, in the course of development, by mechanical injuries. This theory is supported by Lewis who produced various grades of cyclops by pricking the area located between the optic anlagen. He holds that the collapse of the wound surfaces affects the approximation of the two optic anlagen, and the degree of approximation depends on the amount of interocular tissue removed or injured. But objections have been raised to the fusion hypothesis; first, on the ground that cyclopean eyes are rarely equal, in size and extent, to the sum of the two normal eyes combined; second, that experiments made by mechanical injuries cannot account for results produced by chemical means.

The most acceptable theory concerning the etiology of monsters is that of Werber, who concludes from his studies in 1917 on the origin of monsters that parental metabolic toxæmia may be held responsible for the production of monstrosities. He claims that toxic substances resulting from faulty metabolism in the blood of individuals with metabolic disturbances bring about such changes as to produce monsters. But in order to prove the truth of this theory, individuals suffering from such diseases as diabetes, nephritis, etc., should be mated and their offspring studied. Such propositions and conditions are extremely difficult to attain; however, opportunity was afforded the advocate of this theory to imitate the condition by placing ova in a certain percentage of acetone, and he obtained all gradations of monstrosities. The most predominant anomalies he obtained were found in the eyes. He contends that the production of a single eye may be due to a blastolytic injury of a restricted area of the anterior end of the early embryonal stage. This is assumed to be the area most sensitive to toxic action and is the region between the future optic anlagen, or it may even comprise the anlagen themselves. The size of the part affected may be subject to considerable variation: it may include material which would normally correspond to the future interocular region and cause an approximation of the potential optic anlagen; it may extend over the primary optic vesicles, eliminating parts of them, so that by their coalescence and approximation any one of the various degrees of synophthalmic conditions may be formed; or it may comprise the whole of one potential optic anlage and little or no tissue of the future interocular area, causing the embryo to develop into a cyclopean monster if the sound anlage is shifted medianward, or into an asymmetric

monophthalmic monster if no such changes of position of the uninjured ophthalmoblastic material takes place. In addition, he asserts that the changes in position and shape of the mouth, as well as those of the olfactory pits, are due to a process of regulation after a blastolytic destruction of this so-called sensitive area at the anterior end of the early embryo's body.

We believe the retention of the external ears in the region of the neck to be due to the downward displacement of the mouth.

Summary.—In conclusion we might say that the condition here presented may be of interest in three points: First, in its rarity, no similar case that we know of having been as yet scientifically reported in the Philippines; second, in its medico-legal significance; third, it offers an opportunity for the physician to consider the causation of monstrosities, and in particular whether or not the popular belief of maternal impression has a place in science.

BIBLIOGRAPHY

1. Bingham, A. W. Full-term cyclops. Am. Journ. Obs., 77 (1918) 150.
2. Chedester, F. E. Cyclopia in Mammals, Zoölogical Laboratory, Rutgers College.
3. Crocker, W. J. Monstrosities. Journ. Am. Vet. Med. Ass. 54 (1918–19) 387.
4. Fino, C. Note di teratologia. Rassegna d' ostet. e ginec., Napoli 26 (1917) 279 and 372; 27 (1918) 57–70.
5. Kosmak, G. W. A case of twin pregnancy; one child a monster. Med. Rec. N. Y. 93 (1918) 40.
6. Leplat, Georges. Localisation des premiéres ébanches oculaires chez les vertébrés. Pathogenie de la cyclopie. Anat. Anzeig. 46 (1914) 282–89.
7. Mozejko, von B. Ist das Cyclostomenauge primitiv oder degeneriert? Anat. Anzeig. 42 (1912) 612.
8. Rainy, H., and Ballantyne, J. W. Skiagraphic researches in Teratology. Tr. Roy. Soc. Edinb. 1915–1916 51 (1917) 455–460, 15 pls.
9. Smallwood, W. M. Another cyclopian pig. Anat. Anzeig. 46 (1914) 441–445.
10. Stockard, Charles R. The artificial production of eye abnormalities in the chick embryo. Anat. Rec. 8 (1914) 355.
11. Wells, W. W. A study of teratology, with presentation of specimen. Journ. Okla. Med. Assoc. 10 (1917) 16–19.
12. Werber, E. I. Experimental studies on the origin of monsters, II. Regarding the morphogenesis of duplicities. Journ. Exp. Zool. 24 (1917) 409–436, 4 pls.
13. Whitehead, R. H. A case of cyclopia. Anat. Rec. 3 (1909) 285–290.

ILLUSTRATIONS

Plate 1

Fig. 1. Synophthalmia bilentica. Note general shape of face and the two fused eyes with two distinct lenses.
2. Synophthalmia bilentica, side view.
3. Synophthalmia bilentica, showing position of ears and mouth.

Plate 2

Fig. 1. Occipito-frontal, showing one single optic cavity.
2. Side view, left. Note rudimentary lower jaw.
3. Side view, right.

PLATE 1. A CASE OF HUMAN SYNOPHTHALMIA.

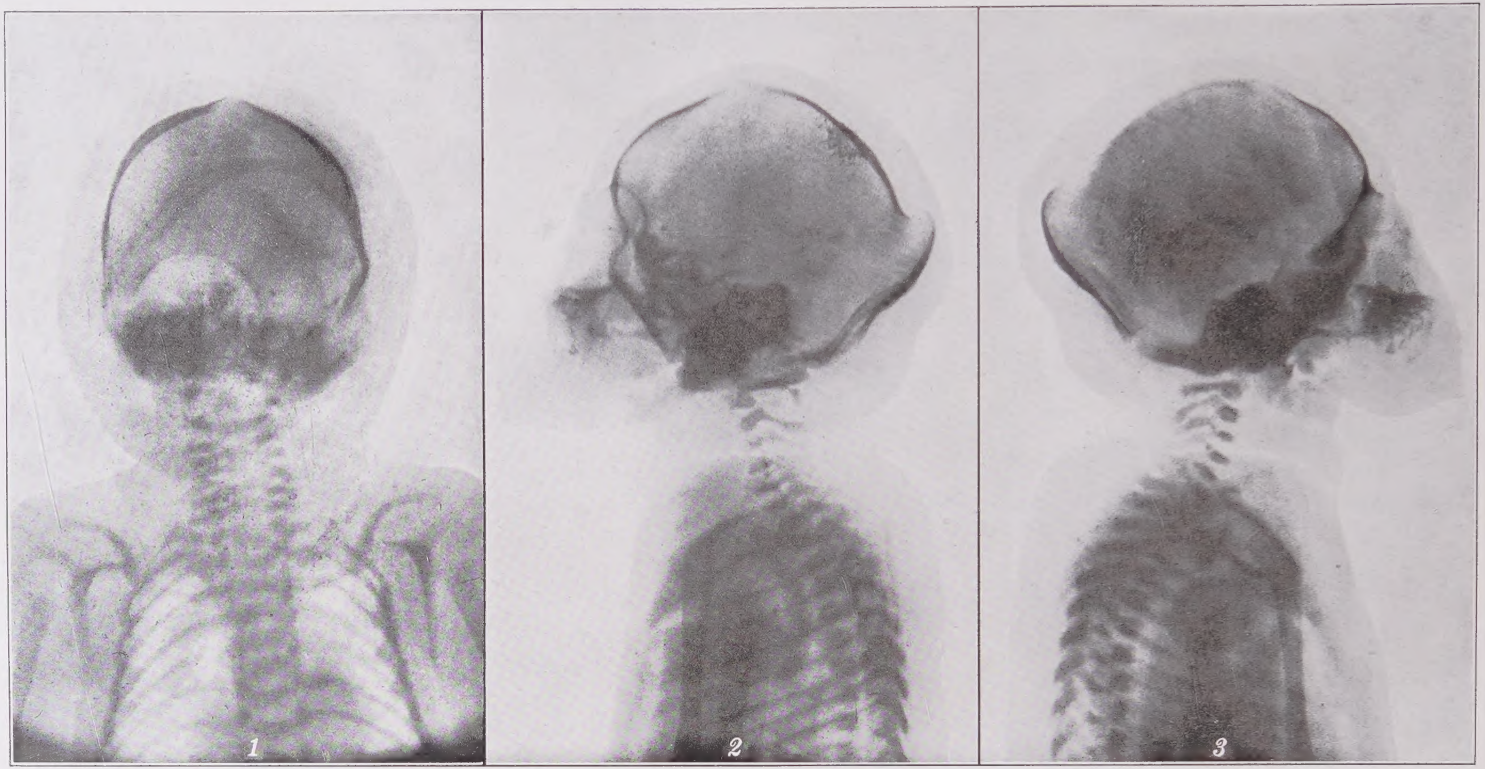

PLATE 2. RADIOGRAPHIC VIEW OF THE SAME CASE OF HUMAN SYNOPHTHALMIA.

REVIEW

The Condensed | Chemical | Dictionary | A reference volume for all requiring quick access to a large | amount of essential data regarding chemicals, and other sub- | stances used in manufacturing and laboratory work | compiled and edited by | the editorial staff | of the Chemical Engineering Catalog | F. M. Turner, Jr., technical editor | assistant editors | D. D. Berolzheimer | W. P. Cutter | John Helfrich | published by | the Chemical Catalog Company, Inc. | One Madison Avenue, New York | first edition, 1919. Cloth, 525 pages, $5.

This handbook is practically a pioneer in its field and is a good indication of the growing importance of chemistry in American business. It is designed especially to meet the needs of business men who encounter questions of a chemical nature.

Brief descriptions of a large number of substances are given, including the formula, physical properties, source, preparation, grades, common containers, uses, fire hazard, and shipping regulations of each. Liberal cross-indexing is furnished and wide margins are left for the insertion of notes.

The dictionary seems to meet a need of purchasing agents, brokers, and other nontechnical men which has hitherto not been satisfied. The chemist, on the other hand, usually prefers a more specialized book with fuller references. The general scope, however, of this dictionary makes it more convenient where only brief information is desired. Many chemists would be at a loss to know just where to look in their libraries for information about names perfectly familiar to other chemists, such as ganister, lewisite, norit.

As is to be expected in the first edition of such a work, occasional mistakes can be found. One can hardly agree with the compilers that kerosene is otherwise known as crude oil, nor that it has a specific gravity of 1.440, boils at 230° to 235° C., and flashes at 150° C. This slip is exceptional, however, and the book on the whole seems to be free from mistakes and misprints.

G. A. P.